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# Journal of the Royal Microscopical Society

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS

AND

A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia)

MICROSCOPY, &c.

EDITED BY

**JOHN W. H. EYRE, M.D. F.R.S. Edin.,**

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WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

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*Regius Professor of Natural History in the  
University of Aberdeen*

**A. N. DISNEY, M.A. B.Sc.**

**F. IAN G. RAWLINS**

FELLOWS OF THE SOCIETY

AND

**A. B. RENDLE, M.A. D.Sc. F.R.S. F.L.S.**

*Keeper, Department of Botany, British Museum*

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quas qui fugit pariter Naturam fugit.—*Linnæus*.

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FOR THE YEAR

1922



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BOTANY,

MICROSCOPY, AND

INDUSTRIAL PROCESSES.

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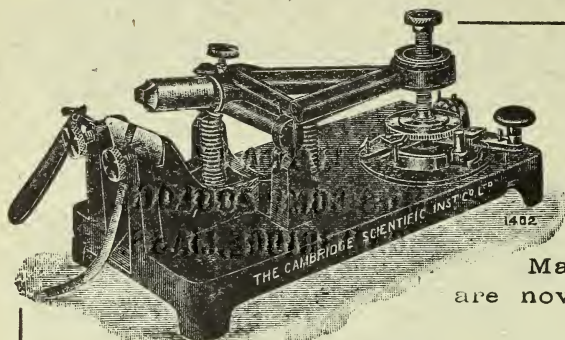
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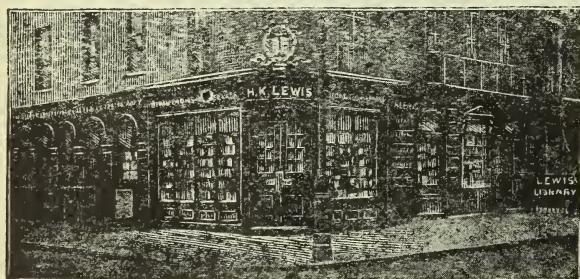
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**ANNUAL SUBSCRIPTIONS.**—The Fellows of the Society are reminded that Annual Subscriptions become due on the first day of January, and early remittance will be greatly esteemed.

**THE BIOLOGICAL SECTION** meets in the Library on the first Wednesday in each month at 7 for 7.30 p.m. Hon. Secretary, Mr. J. WILSON, 3 West Park Road, Kew Gardens, S.W.

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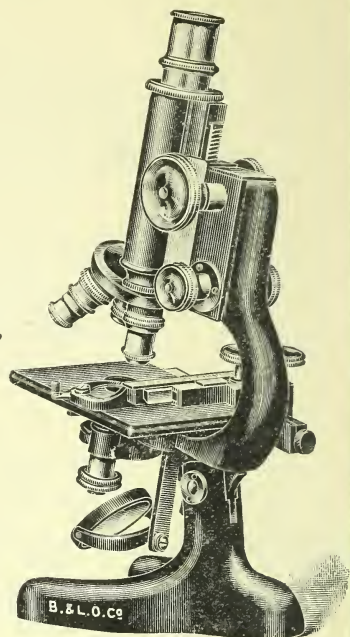
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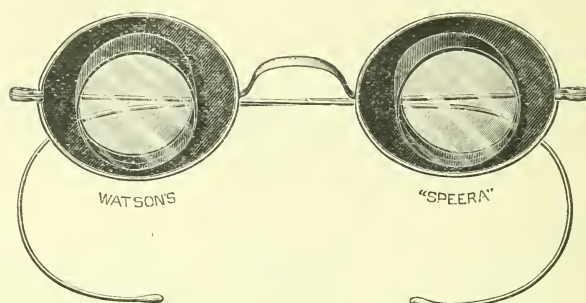
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TRANSACTIONS OF THE SOCIETY.

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I.—THE MICRO-EXAMINATION OF METALS,  
WITH SPECIAL REFERENCE TO SILVER, GOLD AND  
THE PLATINUM METALS.

By GEORGE PATCHIN, A.R.S.M., M.I.M.M.

(Read November 16, 1921.)

TWO PLATES.

THE microscopic examination of metals and alloys is one of the recent developments of the Science of Metallurgy with a direct application to industry, and whilst it is correct to say that microscopic metallography has been developed only within the last few decades, yet it should be remembered that such examination was employed as far back as the seventeenth century.

"Micrographia," written by Robert Hooke, and published in London in 1665, contains, for example, a description of the appearance of lead as it crystallizes from a lead-silver alloy, and also a description of the magnified surface of a piece of polished steel. About a hundred years later, namely in 1772, Réaumur applied the microscope to the examination of cast irons, but apparently his work was connected chiefly with the appearance of fractured surfaces.

Widmanstätten may be said to have laid the first stone of the foundation upon which has been built the present methods employed for the micro-examination of metals, and as is well known he found that some meteorites when cut, polished and suitably

B

etched revealed a characteristic structure visible even to the naked eye. It was the work of Dr. Sorby, of Sheffield, however, that practically inaugurated the new era in the Science of Metallurgy. This great Englishman was the first to undertake the systematic study of the structure of metals by means of micrographic examination, and he was followed some fourteen years later by Prof. Martens. The work of these pioneers was quickly recognized, with the result that the study of physical metallurgy was taken up and extended by Osmond, Howe, Le Chatelier, Roberts-Austen, Stead and many others. The progress has been so great during the last forty years that at the present time most engineering firms of repute have at least one member of the staff fully qualified to carry out a thorough micrographic examination of the metals and alloys used in the industry.

The object of the present paper is to show the importance of the Micro-Examination of Metals and Alloys, and some of the directions in which the microscope is used in connexion with the Metal Industry.

The field of application is fairly considerable at the present time, and is rapidly extending; it includes, amongst others, the determination of:—

1. The presence of foreign bodies.
2. The existence of small quantities of metals, metalloids, etc., which may or may not exert an injurious effect on the materials.
3. The constitution of the alloy.
4. The uniformity with which the constituents are distributed throughout the metallic mass.
5. The effect of stresses, such as those set up by cold working.
6. Crystalline form and size of crystals.
7. The results of heat treatment.
8. The presence of mechanical and physical defects.

As it will be impossible as well as inadvisable to attempt to deal with all the points just named, if this contribution is to be

---

#### EXPLANATION OF PLATE I.

*Fig. 1.*—Iron-phosphide eutectic.  $\times 1000$ .

*Fig. 2.*—Pure silver.  $\times 100$ .

*Fig. 3.*—Pure gold.  $\times 100$ .

*Fig. 4.*—Silver + 1·2 p.c. platinum.  $\times 100$ .

*Fig. 5.*—Silver + 2 p.c. iridium. Section.  $\times 50$ .

*Fig. 6.*—Silver + 0·01 p.c. rhodium.  $\times 15$ .

The magnification as given refers to the original photomicrographs. The illustrations have been reduced and are at a magnification equal to  $\frac{7}{10}$ ths of the figures given.

kept within reasonable limits of size, the author desires to draw attention to the first four points in particular.

## 1. THE PRESENCE OF FOREIGN BODIES.

The term "mechanical enclosure" is sometimes given to these foreign bodies, as they are not an integral part of the substance in question, and have been entangled mechanically by the metal during the process of production, or by the alloy whilst in the fused state.

Wrought iron always contains slag patches due to the iron having been produced in the pasty state, a condition which is not ideal for the complete separation of slag from metal. These patches appear as extended or elongated enclosures if the section examined is in the direction of working, or as more or less rounded masses if the section taken is at right angles to the direction of rolling, drawing or forging.

It might be pointed out here that the chemical composition of wrought iron and very low carbon steel may be almost identical, but the presence or absence of slag patches as revealed by the microscope indicates clearly to which class the metal belongs.

Another common inclusion in iron and steel is manganese sulphide, which occurs in the form of pools or patches of a dove-grey colour, and these patches vary considerably both in shape and size.

Illustrations of slag patches and manganese sulphide may be found in text-books on Iron and Steel, and General Metallography.

## 2. THE EXISTENCE OF SMALL QUANTITIES OF METALS, METALLOIDS, ETC., WHICH MAY OR MAY NOT EXERT AN INJURIOUS EFFECT ON THE METAL.

Small quantities of impurities may exert a great influence on the physical properties of metals and alloys, and whilst the existence of such impurities can be ascertained by micrographic examination, chemical analysis must be employed when a quantitative result is required. Phosphorus, for example, has a marked effect on iron and steel, small quantities causing the latter to be cold short and unreliable under shock, and therefore for that reason the maximum percentage allowed is about 0.05 p.c. During the war period, when so much had to be sacrificed for output, a large quantity of steel was turned out with a somewhat higher percentage of phosphorus than now quoted as the maximum,

and such steel withstood the test to which it was submitted. This does not prove that 0.05 p.c. phosphorus is too low a maximum, but rather that a fairly large margin of safety is allowed.

In the case of cast iron, which is usually made from a mixture of pig irons, much higher percentages may be allowed, and in some cases, especially where thin castings and those of intricate design are required, the phosphorus content may reach 2 p.c., but as in the case of steel, increased phosphorus results in increased brittleness. It is not difficult to microscopically detect the presence of phosphorus in cast iron, particularly after the polished specimen has been heat-tinted, as the phosphorus compound (probably  $\text{Fe}_3\text{P}$ ) forms a characteristic eutectic with iron. This is shown in fig. 1, taken at a magnification of 1000 diameters from a piece of cast iron containing 0.85 p.c. phosphorus.

Small quantities of bismuth or antimony in copper or brass exert an injurious effect by separating as constituents to the crystal boundaries and forming thin brittle walls.

Turning now to the existence of small quantities of metals which do not necessarily exert an injurious effect, the presence of the platinum metals in silver and gold may be cited as an example.

The importance of being able to detect easily the platinum metals, especially during the assay for gold and silver, will be gathered from the increased demand and the high price of these metals. The following table gives the average price of platinum per troy ounce in New York for the years 1911 to 1919 inclusive:—

Per Troy Oz.			At \$5 to the £1		
		\$	£	s.	d.
1911	.	43.12	8	12	6
1912	.	45.55	9	2	3
1913	.	44.88	8	19	6
1914	.	45.14	9	0	7
1915	.	47.13	9	8	6
1916	.	83.40	16	13	8
1917	.	102.82	20	11	5
1918	.	105.95	21	3	10
1919	.	114.61	22	18	6

Gold and silver assays are almost invariably carried out by the dry method, in which gold, silver, platinum, etc., are alloyed with metallic lead and then recovered by cupellation. In cupellation advantage is taken of the fact that the precious metals do not form oxides when heated in the air, whereas lead forms lead oxide which at the temperature of cupellation is sufficiently liquid to allow of it being absorbed by the bed or cupel on which the operation is carried out.

If the operation has been carried out correctly, especially as regards temperature, the resulting bead consists of practically all the precious metals in the original charge of ore and no other metals or impurities.

Cupellation beads of pure silver, when examined under the microscope, show considerable variation in structure, but the common types are fairly large crystal grains with definite boundaries and definite centres of crystallization. The very beautiful appearance of the latter is illustrated in fig. 2.

The micro-examination of cupellation beads of pure gold generally shows distinct crystals, and in some cases it can be seen that crystallization has been from a definite centre and has developed until retarded by interference from adjoining crystals. Fig. 3 illustrates the regularity of development just mentioned.

The appearance of cupellation beads of gold-silver is found to vary more or less in accordance with the proportions of the two metals, beads of high silver content approaching in appearance that of pure silver and vice versa.

It has been known for some considerable time that platinum and its associates could be detected in cupellation beads by the surface crystallization and other surface effects visible to the naked eye. The surface of a silver cupellation bead containing 1.5 to 1.6 p.c. and upwards of platinum, for example, has a frosted appearance detectable by the naked eye, but when smaller quantities are present the surface appearance is quite normal, although some assayers who are experienced in the assay of platiniferous materials claim to be able to detect a difference.

C. O. Bannister and the present author\* have shown, however, that the microscope gives more certain results than the naked eye, and that by microscopic examination of cupellation beads as little as 0.3 p.c. of platinum can be detected when alloyed with silver by the corrugations on the surface of the metal.

With 0.4 p.c. of platinum there is a tendency for the crystal boundaries to show distortion and the slightly corrugated surface visible when 0.3 p.c. is present to be more pronounced. An increase in the platinum content results in an increase in the number of corrugations until with about 1 p.c. the whole surface of the bead is covered. This is illustrated in fig. 4, taken from a bead containing 1.2 p.c. of platinum.

The effect of platinum on silver-gold beads is not so marked as on silver beads, and the effect of this metal on gold beads is even less marked, the corrugations not being as numerous or as well defined.

Palladium, which has been largely used in conjunction with silver in various alloys, does not alter the appearance of the surface

\* *Trans. Inst. M.M.*, 1913-14, Vol. 23.

of silver cupellation bead when present up to 2 p.c., as far as can be ascertained by the naked eye, but when examined under the microscope such beads present an appearance similar to that produced by platinum. The effect of palladium on gold and gold-silver beads has not yet been studied seriously.

Iridium does not appear to alloy with silver at the temperature of cupellation, but owing to its density sinks towards the bottom of the button whilst the latter is in the fluid condition. It has been found, however, that these beads are much more spherical on the upper and lower surfaces, giving to them the appearance of having been expanded by an internal pressure. Micro-examination shows that the crystals are well defined, but the facets are striated, or marked with a series of lines crossing one another after the manner of slip-bands. These markings would seem to confirm the suggestion just made that the beads have been subjected to severe internal stresses, and this is supported by the fact that in a large number of silver-iridium beads a cavity or cavities can be found not far distant from the upper and lower surface. Fig. 5, obtained from the section of a bead containing 2 p.c. iridium, shows the particles near the base of the bead and the cavities to which reference has been made.

Small quantities of rhodium have a very marked effect on silver beads, 0.03 to 0.04 p.c. producing a bluish grey colour due to a film of rhodium or a rhodium compound. With smaller quantities of rhodium, such as 0.01 p.c., the beads are silver white, but a distinct crystallization is set up visible to the naked eye, and so distinct as to give the appearance of a cut gem, as seen in fig. 6.

It may be contended that surface appearances are not to be relied upon, as many factors may influence the result. It should be remembered, however, that cupellation must be carried out as far as possible under standard conditions, and therefore what may apply in the case of other metals does not apply in the phenomena now being considered. The author is continuing this work by endeavouring to ascertain if there is any relation between the internal structure as revealed by polished and etched sections and the surface

#### EXPLANATION OF PLATE II.

*Fig. 7.*—Silver + 1.4 p.c. platinum. Section.  $\times 100$ .

*Fig. 8.*—Silver + 3 p.c. palladium. Section.  $\times 100$ .

*Fig. 9.*—Manganese bronze.  $\times 100$ .

*Fig. 10.*—Manganese bronze.  $\times 100$ .

*Fig. 11.*—Manganese bronze.  $\times 100$ .

*Fig. 12.*—Silver-copper eutectic.

The magnification as given refers to the original photomicrographs. The illustrations have been reduced and are at a magnification equal to  $\frac{1}{10}$ ths of the figures given.

appearance, and, whilst the work is by no means complete, figs. 7 and 8 show a striking similarity to the corrugations produced on the surface by platinum and palladium. These micro-photographs have been obtained from the polished and etched sections of silver beads containing 1.4 p.c. and 3 p.c. of platinum and palladium respectively.

The advantages of the method as described are fairly obvious, for no preliminary polishing, etching or other preparation of the surface is necessary, and either oblique or vertical illumination may be used.

### 3. THE CONSTITUTION OF THE ALLOY.

An alloy may consist of a single constituent, or it may be built up of two or more constituents, and by means of microscopic examination, preceded by suitable etching, differentiation of these constituents can be made.

Manganese bronzes may be cited as illustrations of this point. These so-called bronzes are copper-zinc alloys with small percentages of other metals, such as tin, manganese and iron, and therefore come under the category of brasses. Such alloys are used for a variety of purposes in the engineering industry, and in particular for marine propellers. The composition of these industrial brasses can be estimated satisfactorily by micro-examination in conjunction with the equilibrium diagram of the series. The three phases are named respectively alpha, beta, and alpha + beta. Cast brasses in the normal condition, which show the alpha structure, contain the higher percentage of copper and are the weaker alloys, whilst those with an all-beta structure are poorer in copper, but are superior as regards tensile strength. Alloys with the alpha + beta structure represent intermediate compositions with a tenacity between the two outside limits.

Figs. 9, 10 and 11 show the structure of two manganese bronzes with 75 p.c., 40 p.c. and 5 p.c. alpha respectively.

### 4. THE DISTRIBUTION OF THE CONSTITUENTS.

In an alloy composed of more than one constituent it is important that the various constituents shall be distributed evenly throughout the mass if maximum strength and uniformity of composition and physical properties are to be attained. Owing to the different rates of cooling of a metallic mass from the completely liquid to the completely solid state, and the difference in freezing point of the constituents of the alloy, it is not an uncommon thing

to find that segregation has taken place. Fig. 12 is a photograph of a silver-copper alloy (50 p.c. silver, 50 p.c. copper), which shows the separation of the silver-copper eutectic (72 p.c. silver, 28 p.c. copper) from the excess copper, the eutectic structure being composed of laminae in juxtaposition.

In conclusion, it should be stated that the micro-examination of metals is now a very specialized subject, and therefore it has been possible to deal only in a cursory manner with very few of the aspects of the subject in this paper.

## II.—THE AGE AND GROWTH OF SOME EELS FROM A SMALL WORCESTERSHIRE POND.

BY PROFESSOR A. GANDOLFI HORNYOLD, D.Sc., F.R.M.S.

(Read December 21, 1921.)

EIGHT TEXT-FIGURES.

As far as I know, the only indications as to the growth of the eel in the British Isles are to be found in the work of K. Marcus, who examined eels from the Severn and the Clare in Ireland.

Before the war large quantities of elvers were yearly exported to Germany to increase the eel supply in their waters, and Marcus studied their growth, showing the remarkable success of this experiment in various cases.

The life-history of the eel is as follows: Schmidt has proved that the eel spawns in the Western Atlantic, and the first larval stage, the *Leptocephalus*, has more or less the form of a leaf, and is quite colourless and transparent.

During its migration across the Atlantic, carried by the current of the Gulf Stream, a metamorphosis takes place, and when it arrives on the coasts of Europe the *Leptocephalus* has been transformed into a transparent colourless elver.

The elvers appear at the mouths of rivers during the winter months in enormous quantities, and in some countries are greatly appreciated as food, e.g. on the north coast of Spain, where the elver fishery is of great importance.

Soon after its arrival on the coast pigment develops, first along the sides disposed in chevrons, then the lines double and become confused, and the chromatophores form a homogeneous field on the body. At the same time the elver becomes more and more greenish and opaque, and when the development of the pigment is ended the transparent colourless elver has become a small eel, which now begins to grow.

It is curious that twice during the early life of the eel a reduction in length and volume takes place—once during the metamorphosis of the *Leptocephalus* to the elver, and again during the development of the pigment of the elver. The young eels are called yellow eels because of their ventral colour; the back is greenish, and the colour can vary greatly.

After a number of years which may have been spent in fresh water in estuaries or lagoons near the sea, or even in the latter, as

some eels appear to spend their lives in harbours, etc., the yellow eel changes its aspect; the dorsal colour changes from green to nearly black, the sides look like a freshly-coined penny with splendid metallic reflections, the ventral side becomes silver-white, and the eyes increase greatly in size.

Now the silver eel descends the rivers and returns to the sea to spawn, and never returns, but we do not know if it dies directly after spawning or if it lives for a time.

The silver eel, as it is called because of its ventral coloration, is merely the sexually mature eel, while the yellow is the sexually immature eel.

It must be apparent that the sexual organs of the eel apparently do not attain their full development until the silver eel has entered the sea, though the ovaries of long silver females of 90–100 cm. are enormous and well over 3 cm. across.

All the eels examined here were yellow eels, except a male, 40 cm. long, which was nearly silver.

These small eels were caught from June 22 to July 23 in my pond at Blackmore Park, which is situated about three miles from the Severn at Upton, and lies between Worcester and Great Malvern. All were caught with worm, and the larger ones were mostly captured at night by means of some very primitive night-lines.

The pond is about an acre, divided into two halves by waterfalls, with a small island in the centre, and very full of weed. The pond communicates with the Severn by a stream.

I examined the contents of the stomach of all, and they were usually remains of insects; occasionally I found fresh-water snails as well.

Besides eel the pond contained roach and perch, but I never found any remains of these in the stomachs of the eels, nor did I find any of their smaller brethren, as in some other places.

The eel is most voracious, and seems to have great digestive powers. I have often found up to ten small crabs or some thirty prawns in stomachs of eels caught in estuaries, etc. Sometimes a cannibal had swallowed one of his smaller brethren of such a size that the tail protruded from the mouth, and they were always swallowed head foremost.

The most curious find was at Valencia (Spain) where I found in the stomach of an eel, some 40 cm. long, a sparrow swallowed whole. No doubt the bird had died and somehow got into the lagoon.

I have seen eels caught in swamps gorged with mosquito larvæ, and perhaps eels might be useful in the fight against malaria. In Majorca, where the inhabitants depend chiefly on rain-water for drinking as well as for household use, a few eels are generally put into the cisterns to keep the water pure! At least they destroy some mosquito larvæ.

What I have said about the voraciousness of the eel applies only to the yellow eel, as the silver eel does not take food, at least usually, and one nearly always finds their stomachs empty.

There is a great difference between the flesh of the yellow and the silver eel, for the latter is much firmer, and I think that anyone used to handling large quantities of eels could pick them out blindfolded.

The silver eel has nearly reached its full development and has accumulated fat in its tissues before commencing the long voyage to its Atlantic spawning ground, and we know that in other fish the development of the sexual products takes place at the cost of other tissues—for example, the great difference between a salmon entering a river to spawn and a spent kelt. The silver eels are actually sold at higher prices than the yellow ones.

The methods usually employed to ascertain the age of fish are the enumeration of the zones of growth of the scales, otoliths and vertebræ, much the same as can be done with sections of trees.

With some fish the scales give the best results, with others the otoliths or vertebræ, as also the operculum, but one can always succeed with one of these methods.

In the eel the scales were first used for finding the age by Gernsøe, and Ehrenbaum later proved that the otoliths give the best results; but it is always interesting to compare the difference between the number of zones on the scales and the otoliths in eels taken from various places.

The structure of the scale of the eel is different from that of most other Telersteian fishes, and consists of a more or less oval plate of fibrous tissue. I cannot better describe its structure than by quoting from "British Fresh Water Fishes" by C. Tate Regan, 1920, p. 162:

"When a scale is examined under the microscope the outer surface is seen to be studded with little calcareous buttons, which are arranged in zones or rings parallel to the edges, and are separated from each other by narrow rings occupied only by the fibrous ground substance of the scale. This structure is due to the fact that the eel feeds and grows actively in the summer months only, and the zones are annual rings formed during the summer, whilst the narrow interspaces represent the growth of the scale in the colder months."

The first scales appear above the lateral line near the anus, and therefore the scales taken from this region are the oldest, and they are not formed until the eel has attained a length of from 15–20 cm. The centre of the scale is, like the interspaces, devoid of calcareous buttons, and I call the middle zone, which is first formed, the central zone.

Fig. 1 represents a scale taken from a silver male of 37 cm. and 52 grams, with a central zone C and four others, in all five zones.

The scales have not always the normal structure as described, sometimes a scale may have one or more incomplete zones, as in fig. 2. These incomplete zones or caps must naturally always be counted as well as the normal ones; they are often to be found in the scales of large eels, and one can find all kinds of transition forms between these and normal zones.

Scales can grow together, and unite the succeeding zones, form-



FIG. 1.

ing quite normally in each scale, as in fig. 3, or the succeeding zone grows round them both, as in fig. 4.

One also finds from time to time scales having quite abnormal forms, as in figs. 5 and 6, no doubt from the same cause.

It is quite easy to obtain fine preparations of eel scales by the following method:—

First carefully remove all slime or mucus from the skin by rubbing it several times with talcum, and afterwards with cotton wool steeped in 90° alcohol.

The skin is then moistened again with water, and the scales are easily removed by scraping it with a sharp dissecting knife and placed in water.

If the skin has been properly cleaned in the way just stated, one can count the zones at once, otherwise one must macerate the scales for about twenty-four hours, or even more, and centrifuge them, changing the water several times.

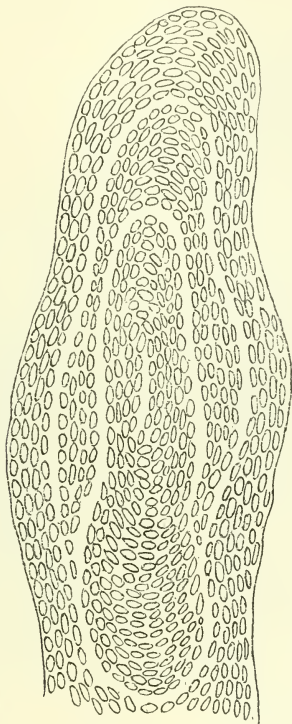


FIG. 2.

The most useful powers for scale work are  $1\frac{1}{4}$  in., 1 in., and  $\frac{1}{2}$  in., and a microscope with a Porro prism is most convenient to work with, as any interesting or curious scale can be selected with the greatest ease.

Instead of slides I prefer to use spoiled stereoscopic plates, and recommend, according to the size of the stage of the microscope, either 6 by 13 cm., or Verascope size.

It is well to examine some twenty to thirty scales taken from

above and below the lateral line just in front of the anus, where, as I have said before, the first scales appear.

I take the scales from both sides of the body so as to be perfectly sure of obtaining the oldest scales, as it might be possible that at some time one side had received some injury, and the scales might have been formed again, but would naturally be younger.

The otoliths of the eel are more or less oval, one side is convex

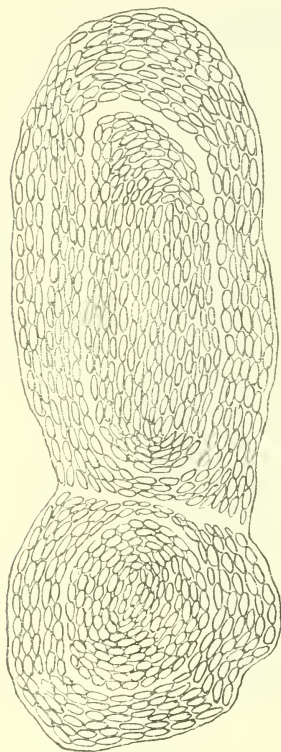


FIG. 3.

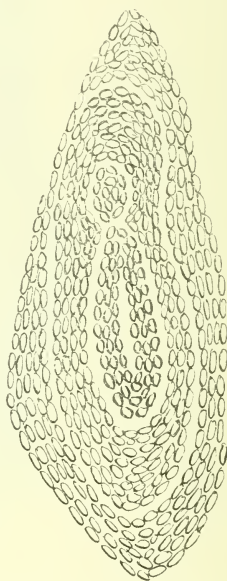


FIG. 4.

and the other concave. Marcus compared their shape with that of the hand.

They consist of calcium carborate, and an organic substratum. When examined on a background their white slightly bluish colour reminds one of Carrara marble.

Otoliths are easily dissolved by any acid; and formalin must be avoided for this reason, they dissolve with effervescence, leaving the organic substratum intact.

It is possible to destroy the otoliths by boiling with caustic potash or soda.

One can extract them in this way, as the bones of the skull are attacked more quickly than the otoliths, but I do not recommend it, as often the otoliths are damaged if it is not carried out with the greatest care. I myself have spoiled much valuable material in this manner before learning better.

It is not easy to find exact indications as to the preparation of the otoliths of the eel, and it cost me some trouble to find it out. I prepare the otoliths in the following manner:—

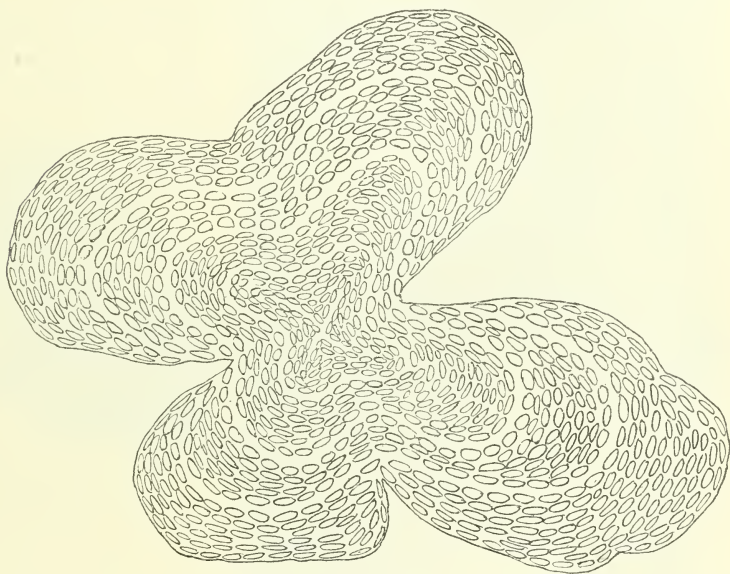


FIG. 5.

As the lower jaws are of no use, they can be removed at once, and the head is now cut off at the beginning of the gills. If one is collecting material in various localities, each skull can be wrapped up in a small linen square tied up with thread, together with a parchment label on which is written with Indian ink the number and locality of specimen.

Each ten skulls are wrapped up in a larger linen square marked with the locality and the Roman numbers I, II, III, etc., which indicate that the packet contains Nos. 1-10, 11-20, 21-30, etc., of a locality.

The skulls can be left in 70° alcohol till wanted. Of course

the otoliths can be immediately extracted and kept in insect tubes in alcohol till wanted (the japanned tin cases containing two dozen tubes sold by Messrs. Watkins, Strand, are most useful).

The easiest way of extracting the otoliths is to divide the skull with a pair of strong surgical scissors, remove the brain with fine-pointed forceps, and the otoliths can be seen and extracted without the least difficulty.

Messrs. Watsons' "Speera" lens is most useful for this work, as both hands are left free.

The otoliths are cleaned by rubbing between thumb and forefinger, dehydrated for a moment in absolute alcohol, and cleared by leaving them overnight in xylol or creosote.

I personally prefer creosote to xylol, as it can be obtained at

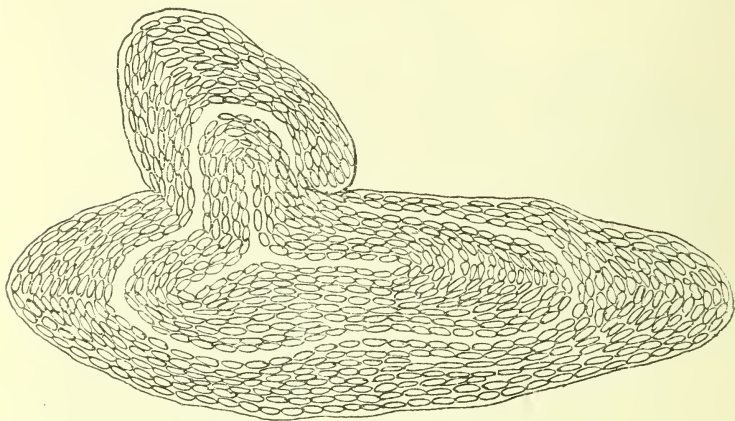


FIG. 6.

any chemist's, and the otoliths become even more transparent. One must use pure beech creosote, as if one wishes to mount any interesting otolith in Canada balsam it can be done, and the creosote can even be used more than once.

At a meeting of this Society I heard Dr. Murray describe a mixture of equal parts chloral hydrate and carbolic acid melted by heat for clearing fleas, and I found that this mixture gives excellent results with small otoliths.

I now examine in creosote with a low power, say  $1\frac{1}{2}$ –2", and if all the zones are not clearly visible the otoliths are replaced for a moment in absolute alcohol, then in water, and the convex side is now ground down by rubbing on a carborundum stone, the forefinger being protected by one of the linen squares used to pack the skulls.

One controls the operation by replacing in creosote, repeating this till all the zones are clearly visible. It is best to grind down only one otolith, keeping the other for control.

The stone must be well rinsed after grinding each otolith, as fragments of linen adhere and cause the otoliths to break. The grinding down must be done very carefully, bearing in mind that one can grind away, but cannot replace. The first examination in creosote is a good guide as to the amount of grinding needed.



FIG. 7.

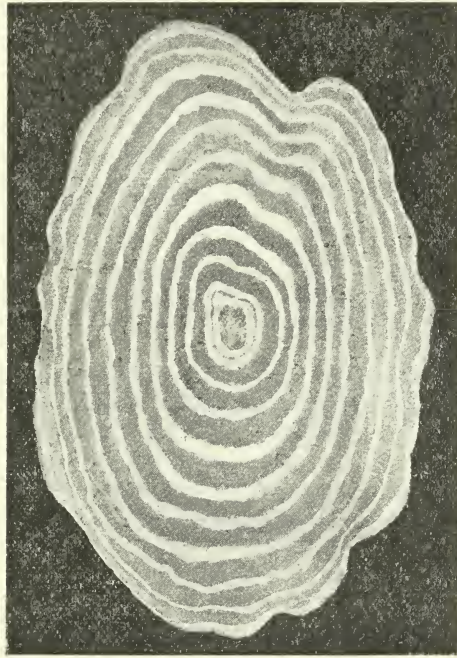


FIG. 8.

It is only right to state that some otoliths give better preparations than others and show the zones more clearly. Some are also thicker than others. In some one can count the zones without grinding down, or at most very slightly; in others it is only after grinding down and examining in creosote several times that one can count them accurately.

With otoliths of very large eels it is pretty well impossible to count the zones exactly, as they are so close together. In some localities the otoliths appear to be more transparent than in others.

An otolith examined with a low power in creosote, etc., shows

the following structure :—In the centre a nucleus, which consists of two dark opaque rings or zones very close together, which are formed during the first period of life in the sea, and Haempel calls them “*Seewasserringe*,” or sea-water rings, for this reason (fig. 7). These figures were drawn from otoliths examined by dark-ground illumination; the dark zones appear white.

In many otoliths the central nucleus looks like a thick dark ring, and the two zones only show after grinding down. Next comes a broader light zone, which is formed during the first summer after its arrival as an elver on the coast.

The transparent elver during the development of the pigment suffers a reduction in length and volume, and the first definite growth begins when this is ended.

The broad light zone is followed by a narrow dark opaque zone formed during the first winter, when the growth is slower, and, according to the age of the eel, we would observe a lesser or greater number of zones, light and broad summer, dark and narrow winter; these indicate the age of the eel from the time of its arrival as an elver on the coast (fig. 8 represents the otolith of a silver male belonging to the group VIII).

Thus the groups O, I, II, III, IV, etc., mean that the eels in question have 0, 1, 2, 3 and 4 dark winter zones on their otoliths.

The last exterior zone is only to be counted if completely formed. Naturally if we refer to an eel belonging to, say, the group V, it is really in its sixth year.

There is always a difference between the number of zones of the otoliths and those of the scales.

In the first place the scales only appear when the eel is about 16 cm. or about 6 in. long at least, sometimes even when the eel is 18–20 cm. or 7–8 in. long.

It is obvious that as the growth of the eel varies in different localities, the initial difference varies also. The scales may appear in the second or third year, or even perhaps later, according to the localities.

If subsequently the zones on the scales were formed regularly each year, we could find out the age of the eels of a given locality by adding two or three, etc., to the number of zones, having previously found the age in which the first scales appear.

Unfortunately, this is by no means the case, and in eels of a certain age the initial difference of the 2–3, etc., may greatly increase. I have seen eels of 40 cm. which had only two zones on the scales, and even cases where there were no zones at all. The otoliths would have had probably seven zones or more. Personally I believe that the difference (D) between the number of zones of the otoliths and the scales does not remain constant during the life of

the eel, but varies according to the faster or slower development of the various zones of the scales.

The Roman figures I, II and III behind the number of zones of the scales indicate that there was a lesser or greater quantity of scales having this number of zones on the eels in question. For instance, 3 I means that there were not many scales with three zones, and that it needed some trouble to find them. 3 II means that there were a fair number of such scales, and that they could be found without difficulty. 3 III means that the majority of the scales examined had three zones. In some cases even practically all the scales may have the same number of zones, and one searches in vain for even one scale having one more zone.

Sometimes one finds perhaps only 1-2 scales having the highest number of zones, and often the zone may be incomplete, forming a cap on the preceding zone, either internally or externally

The eels belonged to the following age groups:—

#### GROUP V.

Number	Length cm.	Number of zones on scales	D
77	21	1	4

The only eel of this group I caught measured 21 cm., and it was impossible to determine its sex. There were numerous scales, but without any zones of growth, and D therefore was 4.

#### GROUP VI.

I was not fortunate enough to capture any eel of this group.

#### GROUP VII.

##### *Males.*

Number	Length cm.	Number of zones on scales	D
2	32	3	4
42	30	3	4

Two males, length 30-32 cm., D 4. Average length 31 cm.

##### *Females.*

Number	Length cm.	Number of zones on scales	D
37	36	3 III	4
29	35	3 II	4
38	33	3 II	4
25	30	3 I	4

Four females, length 30-36 cm., D 4. Average length 33.5 cm.

## GROUP VIII.

*Males.*

Number	Length cm.	Number of zones on scales	D
24	34	3 II	5
44	33	3 II	5
10	33	3 I	5
30	32	3 II	5
33	32	3 I	5
66	32	2 I	6
63	31	2 III	6
16	30	3 I	5
56	29	3 II	5
34	28	3 I	5
21	28	2 III	6
28	27	2 III	6
19	25	2 III	6

Thirteen males, length 25–34 cm., D 5–6. Average length 30 cm.

*Females.*

Number	Length cm.	Number of zones on scales	D
7	37	4 I	4
65	37	3 I	5
71	36	3 II	5
48	35	3 II	5
22	33	3 II	5
52	33	4 I	4
5	31	3 II	5

Seven females, 31–36 cm., D 4–5. Average length 34.57 cm.

## GROUP IX.

*Males.*

Number	Length cm.	Number of zones on scales	D
26	37	4 I	5
11	35	3 I	6
35	35	3 II	6
76	35	3 II	6
1	34	3 II	6
14	34	3 II	6
41	34	4 I	5
72	34	3 II	6
3	34	3 II	6
46	33	4 I	5
62	32	3 II	5
58	31	3 I	5
4	20	3 I	5

Thirteen males, length 30–37 cm., D 5–6. Average length 33.69 cm.

*Females.*

Number	Length cm.	Number of zones on scales	D
6	40	4 I	5
8	39	4 I	5
15	38	3 II	6
47	38	4 II	5
20	37	4 I	5
17	35	3 III	6
49	35	3 III	6
32	34	3 II	6
39	34	4 I	5
34	34	3 II	6
67	34	3 II	6
68	33	4 I	5
50	28	3 I	6

Thirteen females, length 26–40 cm., D 5–6. Average length 34·41 cm.

GROUP X.

*Females.*

Number	Length cm.	Number of zones on scales	D
40	45	5 I	5
9	42	4 II	6
57	38	3 II	7
78	36	3 II	7

Four females, length 36–45 cm., D 5–7. Average length 40·5 cm.

GROUP XI.

*Females.*

Number	Length cm.	Number of zones on scales	D
12	46	4 I	7
56	45	5 I	6
61	42	4 I	7
18	41	3 III	8
70	41	4 II	7
27	40	4 I	7
69	38	4 I	7

Seven females, length 38–46 cm., D 6–8. Average length 41·85 cm.

*Male.*

Number	Length cm.	Number of zones on scales	D
59	30	5 I	5

One male, length 36 cm.

*Male.*

Number	Length cm.	Number of zones on scales	D
75	40	5 I	6

One male, length 40 cm.

## GROUP XII.

*Females.*

Number	Length cm.	Number of zones on scales	D
51	45	4 II	8
36	44	4 II	8
13	43	3 III	9
64	43	4 II	8
43	41	5 I	7

Four females, length 41-45 cm., D 7-9. Average length 44 cm.

## GROUP XIII.

*Females.*

Number	Length cm.	Number of zones on scales	D
60	49	4 I	8
74	48	4 I	8
55	47	4 II	8
45	42	5 I	7

Four females, length 42-49 cm., D 7-8. Average length 44.5 cm.

## GROUP XIV.

*Female.*

Number	Length cm.	Number of zones on scales	D
73	48	4 I	10

One female, length 48 cm.

## GROUP XV.

*Female.*

Number	Length cm.	Number of zones on scales	D
31	48	5 I	10

One female, length 48 cm.

A table of the average lengths of the different age groups would show the growth of these eels more or less accurately if each group had about the same number of eels, and better still if for both sexes. Unfortunately, this was not possible, and therefore the results are more or less accurate according to the number in each group. Take, for instance, the males. I caught 2 belonging to group VII, 13 to VIII, 13 to IX, and 1 each to X and XI. It is quite obvious that one can compare averages taken from equal numbers more accurately than from 12 and 2. This also applies to the females; and for this reason I give below the average lengths in this table, the number of eels in each age group, as also the differences I observed between the number of zones of the scales and the otoliths.

In all I examined 78 eels (30 males, 46 females, and 2 of undeterminable sex), and I add here that all these 76 eels had perfectly well-developed sexual organs leaving no possible doubt as to their sex.

The zones on the otoliths were counted several times, and the grinding down was carried out with the greatest possible care.

*Males.*

Group .. ..	VII	VIII	IX	X	XI
Length in cm. . .	31	30·30	31·69	36	40
Number of eels	2	14	12	1	1
D .. .. .	4	4-6	5-6	5	6

All the males were yellow eels except the one belonging to group XI, which was nearly silver; the eyes were enlarged, the dorsal side and pectoral fins were nearly black, but the ventral side was slightly grey; the sides showed bronze metallic reflections, and the flesh was quite firm.

*Females.*

Group .. ..	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
Length in cm. . .	33·5	34·57	34·41	40·5	41·35	44	44·5	48	48
Number of eels	4	7	13	4	7	5	4	1	1
D .. .. .	4	4-5	5-6	5-7	6-8	7-9	8-9	10	10

All the females were yellow eels, although in some of the larger ones the ovaries were beginning to be opaque like those of silver females.

The two eels of undeterminable sex belonged to the groups V and VIII.

Group .. .. .	V	VIII
Length in cm. ..	21	26
D .. .. .	4	6

Although I have not been able to examine a larger number of eels from this pond, it is sufficient to show that their growth is very slow indeed.

Usually one finds a considerable difference between the males and females after the groups IV or V, but here we find eels of both sexes belonging to groups VIII and IX having the same length. In group VIII the males vary from 27–34 cm. and the females from 31–37 cm., and in group IX the males vary from 31–37 cm. and the females from 28–40 cm.

In group VIII 2 males and 2 females measure 33 cm., and in group IX 5 males and 4 females measure 34 cm., and 2 males and 3 females 35 cm. We even find in group VIII a female measuring only 31 cm., and in group IX one even smaller, 28 cm. The smallest male of group VIII measured 25 cm., and of group IX 30 cm.

The largest females belonging to groups X–XV, measuring from 45–49 cm., have an extraordinarily slow growth even then.

Under favourable conditions the eel can grow fast, and Marcus gives an example of elvers taken from the Severn and sent to the Paprotker Lake in East Prussia, where in about  $4\frac{1}{2}$  years the females grew to 50 cm., and I have seen in Spain females from 45–55 cm. belonging to the group VII.

It would not be possible to find out even very approximately the age of these eels by the zones on their scales, as the difference increases so greatly in the older age groups.

The only member of group V showed a difference of 4 zones, but later we find up to 10.

It is difficult to count accurately the zones of the otoliths of large eels, as they are so close together; but there is no doubt that eels can live to a great age, growing to a great size like those large females modelled in the Science Museum and the Natural History Museum.

The French naturalist Dareste kept an eel in captivity for over thirty years, and obviously the animal must have been some years old before he had it.

That eels can live under very unfavourable conditions is proved by the experiment of my late friend Professor Jung, of Geneva, who kept an eel over four years without food.

I think that the exceedingly slow growth of these eels can be put down to the unfavourable conditions prevailing in this pond.

There is a great difference in the growth of the two sexes; the males remain much smaller than the females.

The largest male known only measured 51 cm., but females can grow up to 1.50 metre, and I myself have seen females over a metre long.

The males rarely measure more than 48 cm., and it is quite common to find silver males in localities near the sea measuring from 33–40 cm.

The smallest silver males measure 29 cm., but one does not often find silver females measuring less than 45 cm. Naturally the males became silvered before the females; one can find silver males belonging to group IV, but more often to groups V, VI, VII, and VIII. The females take at least two years longer than the males of the various localities where I have collected eels.

Personally, I have not seen a silver female younger than group VII, but probably under very favourable conditions they may mature earlier. The age of silver females varies greatly, and I have seen otoliths having certainly 15 dark zones. Their size also varies greatly; one can obtain specimens 45–50 cm. long perfectly silvered, and one can find large yellow females of over 80 cm.

The males do not migrate so far from the sea as the females, and for this reason if one examines a quantity of small eels caught in a lagoon, estuary, etc., of, say, from 30–40 cm. long, the great majority will be males.

I have not caught enough roach to be able to say much about their growth, but the perch, which are easily caught, are mostly very small, usually from 15–20 cm. or from 6–8 inches long; I only once caught one of 8 ozs.

As I only examined one nearly silver male I cannot say at what age they become silver eels; but judging from the growth I should not expect the males to do so before reaching groups VIII and IX, but perhaps some might with VII.

The females would probably take at least two years more. Under favourable conditions the males might become silvered with groups IV and V, but the age of the silver eels varies greatly.

As I said before, this paper has no pretensions to be a study of the growth of the eels in this pond, but to show that under unfavourable conditions the eel can grow very slowly indeed.

Unfortunately I did not examine a sufficient number of eels to obtain accurate averages for the different age groups. It would have been preferable to have examined eels caught during the winter months when growth is slow, but circumstances prevented this.

The eel is commonly supposed to be a fast-growing fish, and

under favourable conditions this can be so, but otherwise the growth may be very slow, as in the present case.

I examined the intestines of these eels for intestinal parasites, which I forwarded to Dr. Baylis, of the Natural History Museum, who kindly classified them for me. He found the following, all previously found in the eel :—

*Ptychobotrium claviceps* (Goeze, 1782).

*Echinorhynchus salmonis* (Müller, 1784).

*Ascaris cristata* (v. Linstow, 1782).

I take the opportunity to thank Dr. Baylis most sincerely. I also thank Mr. C. Tate Regan, F.R.S., Keeper of Geology, British Museum, who very kindly allowed me to prepare some of the otoliths in the Museum laboratory.

The readers who wish to know more about the determination of growth of the eels by means of the otoliths can consult the following papers :—

1. EHRENBAUM, E., & MARUKAMA, H.—Über Alterbestimmung und Wachstum beim Aal. Zeitschr. für Fischerei, Bd. 14, 39–127 (1912).
2. HAEMPEL, O., & NERESHEIMER, E.—Über Altersbestimmung und Wachstum des Aals. Zeitschr. für Fischerei, Bd. 14, 265–81 (1914).
3. MARCUS, K.—Über Alter und Wachstum des Aales. Aus Mitteilungen aus dem Zoologischen Museum, Bd. XXXVI (Hamburg, 1919).
4. WUNDSCH, H.—Neue Beiträge zu der Frage nach dem Alter und Wachstum des Aales. Zeitschr. für Fischerei, Bd. 18, 55–88 (1916).

### III.—NOTES ON FRESH-WATER CILIATE PROTOZOA OF INDIA.—II.

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of Zoology, Government College, Lahore.

#### INTRODUCTION.

IN my previous paper published in this journal (3\*) I referred in brief to the work of other authors who had studied the Indian fresh-water Protozoa, and remarked on the extremely meagre attention which had been bestowed on this large, varied, and interesting group in this country (1, 2, 4, 5, 6, 7, 8, 9, 10, 11). After recording my own observations on a number of Ciliates, I appended a complete table of species which had been recorded from India so far. Since communicating those observations, I have had the opportunity of continuing the work on the group, and have come across, at Lahore, a number of other forms which it is the object of this paper to record. My best thanks are due to Mr. Clifford Dobell, F.R.S., for his great kindness in reading the proofs of this and the previous paper, and making some valuable suggestions.

#### RECORD OF OBSERVATIONS.

##### HOLOTRICHA.

##### Family HOLOPHRYINA Perty.

##### Genus *Prorodon* Ehrbg.

##### *Prorodon edentatus* Claparède & Lachmann.

Specimens referable to this species were found in water from the tanks in the Shalamar Gardens, near Lahore, in June 1920. The water collected was from the tanks on the lowest flat in the Gardens, and the animals were found in the tube at the junction of water and bottom mud. An average specimen measured  $74\mu$  by  $24\mu$ . The body was flexible, longitudinally striate, and with its anterior part more transparent. The cilia were uniform all over the body, and the anterior end showed a small beak-like

\* The italic figures within brackets refer to the list of references at the end of the paper.

projection curved to one side. The mouth was anterior, eccentric, and was followed by a short, narrow, conical gullet, without any cilia or rod apparatus. The macronucleus was small, oval, and situated in the anterior half of the body. The contractile vacuole was very large and situated near the posterior end. The anal aperture was postero-terminal, in a slight indentation of the posterior margin of the body.

The form differed however from the type, as described and figured by the original authors, in the following features:—The anterior and posterior margins of the body were not regularly rounded; there was no tuft of longer cilia at the posterior end; the pharyngeal tube did not extend to the centre of the body, but only a short distance behind the anterior end; the macronucleus was proportionately much smaller and situated in the anterior half of the body. All these features give the form examined by me a distinctive look, but do not justify, in my opinion, the creation of a new species for it.

#### Family ACTINOBOLINA Ehrbg.

##### Genus *Coleps* Nitzsch.

##### *Coleps kenti* sp. n.

Forms closely resembling *C. hirtus* were met with in August 1918, but differed from the latter in being proportionately much broader, and in the absence of apical projections and posterior spines. Kent (19) also had observed forms "in which no cusps whatever were developed at the posterior extremity, the size, quadrangular corrugation, and deeper longitudinal lines or furrows being, in common with all other essential structural details, identical with what obtains in *C. hirtus*. . . . While the comparative length and breadth in the examples examined averaged in most instances the proportions of two to one, much shorter and almost subspheroidal specimens were not unfrequently encountered." He however thought that "this well-marked variety should perhaps be properly referred to the genus *Plagiopogon*." But the genus *Plagiopogon* was founded by Stein for *Coleps*-like forms which, though not possessing apical or posterior spines, are only longitudinally furrowed, and in which the surface is not marked off into quadrangular areas and does not bear a coat of mail as *Coleps* does. The form encountered by me is practically the same as that described by Kent, and regarded by him as a distinct variety of, or a most closely allied species to, *C. hirtus*, except for the fact that in the specimens that came under my observation, I did not find the proportion of length to breadth as two to one, the average measurements being  $52\mu$  long and  $39\mu$  broad. For the reason men-

tioned above I would not refer his form and mine to *Plagiopogon*, but as they merit separate specific distinction I would, in honour of its discoverer, confer upon it the title of *Coleps kenti*.

*Coleps uncinatus* Claparède & Lachmann.

Forms belonging to this species were found in the water of a pond situated in the Lawrence Gardens in August 1918. The body was elongated, oval, and provided with four posterior spines. The average size of the specimens was  $70\mu$  by  $28\mu$ . On staining with acetic methyl-green the spherical macronucleus and the small micronucleus situated close by it were observed.

Family CYCLODININA Stein.

Genus *Didinium* Stein.

*Didinium balbianii* Bütschli.

Specimens of this rare form, with only a single ciliary wreath near the base of the proboscis, were found in the water from a pond near the river Ravi in October 1919.

Family TRACHELINA Stein.

Genus *Dileptus* Dujardin emend. Wrzesniowski.

*Dileptus gigas* (Clap. & Lachm.) Wrzesniowski.

(Syn. *Vibrio anser* O. F. Müller, *Amphileptus gigas* Claparède & Lachmann.)

Animalcules belonging to this species were found in water from a small pool on the bank of the river Ravi in July 1920. The water collected contained the bottom mud and leaves of some grass which was growing in the pool. Specimens, though not sticking to the grass, were invariably found by placing on the slide a leaf with a drop of water containing the forms and then removing the leaf. The body and the neck showed movements which are so characteristic of the species. Specimens were however smaller than the size usually recorded for the species. They measured on an average  $200\mu$  only. The ratio between the length of the neck and that of the rest of the body varies a good deal in this species, and in the specimens that came under my observation was as 2 to 3. The cilia covering the body were very fine and close-set, and the neck showed a narrow groove along which the stronger adoral cilia were situated. The body did not show any longitudinal striations, but the endoplasm was finely granular. The row of contractile vacuoles extended into the proboscis also. The tail was obtusely pointed, and not drawn out into a distinct prolongation.

## Family CHLAMYDODONTA Stein.

Genus *Chilodon* Ehrbg.*Chilodon steini* Blochmann.

Found in water containing bottom mud, from a small pool close to the bank of the river Ravi in July 1920. An average specimen measured  $90\mu$  by  $42\mu$ . The body was strongly asymmetrical, flattened and flexible, and the animal moved with a gliding and undulating movement. The longitudinal striations were fine, but well marked, and the ciliation was fine and close. The mouth was situated in the anterior third of the body, succeeded by a trumpet-shaped gullet containing delicate rods. The oblique line of cilia which generally extends from the beak to the gullet was not present in the specimen that came under my observation, which appears to be the case in certain other species also—for instance, *C. dubius* Maup. and *C. gourandi* Certes. Numerous small vesiculæ were distributed in all parts of the body, including the beak. The macronucleus was large, oval, finely granular, and contained a large central, vesicular body. The micronucleus could not be made out. The body did not contain any diatoms, but round disc-shaped, or oval green algæ.

## Family PLEURONEMINA Bütschli.

Genus *Cyclidium* (Hill) Ehrbg.*Cyclidium glaucoma* O.F.M. emend. Ehrbg.

Numerous specimens of this species were found in water from a fountain-pond in Mozang in May 1920, and measured on an average  $18\mu$  in length. The body was egg-shaped, with an elongated bristle at the posterior end, and the cilia were fine and elongated. The cuticular surface was longitudinally striate. The peristome did not extend much further behind the middle of the body, and the undulating membrane was large, hood-like, and extensible. The macronucleus was central, and the contractile vacuole was situated near the posterior end.

## HETEROTRICHA.

## Family BURSARINA Bütschli.

Genus *Bursaria* O. F. Müller.*Bursaria truncatella* O.F.M.

Specimens referable to this species were found in considerable numbers in the water of a burrow-pit (*chaubacha*), close to a garden well in the Gol Bagh, in December 1919. As observed by Kent, the species "is apparently by no means a cosmopolitan form, but

where found usually occurs in considerable abundance." The water was collected on December 16, and kept in the laboratory in an open-mouthed jar. The specimens were found mostly in the debris of silt at the bottom of the jar, and there were practically no other Ciliates in the same water. Individuals were of quite a large size, easily visible to the naked eye, and opalescent white in appearance, creeping about slowly. The specimens at first lived well, but three days later, i.e. on December 19, no more specimens could be found in the jar, nor in another sample of water from the same place. Probably all had died in consequence of a marked fall of temperature during the preceding night.

As regards the structure of the form I have nothing to add to the elaborate figure and description given by Schuberg and copied by Bütschli (13), Lang (20), and Hickson (18). All these authorities seem to differ, however, in their interpretation of the same figure which they reproduce from Schuberg. These differences concern the position of the mouth, the character of the gullet, the exact boundaries of the peristome, and the presence or absence of membranes inside it. Bütschli, for example, in his description of the genus, says as follows:—

"The narrowed, gullet-like, hinder part of the peristome usually bends round to the left, and runs into an oval aperture. Adjoining this there is, however, a long and very slender buccal cleft, lying slightly on the right side and extending along nearly the whole peristome." On referring to the legend to his figure (Plate LXVII, fig. 6, *a*), we find "*m s p*." The long buccal cleft, on the right side, leading right through the peristomial cavity to the end (*o*) of the gullet." The structure referred to as "the gullet" appears to be the bent portion of the peristome, though it would have been better to place the letter *o* a little lower on the figure—i.e. at the end of the actual tubular cavity of the peristome, and not on the membranellæ of the adoral zone. Lang (pp. 143-4) altogether avoids the mention of any gullet, and simply says:—"The cytostome is a long cleft, which extends from before backwards in the peristomial wall, on the right side, as far as the hindmost extremity of the peristomial sac." Hickson (p. 407), referring to this cleft, described it as "a gutter (*m*) leading down to the mouth, and this is continued into a narrow cesophagus" (*o*). It is best, in my opinion, to say that there is no gullet in this animal, though there is a posterior tube-like continuation of the peristome, as, properly speaking, there is no cytopharynx following a definite cytostome, the gutter-like cleft serving the purpose of a mouth opening.

Again, Bütschli says:—"Ciliation moderate; the peristomial field unciliated. Undulating membrane wanting." Lang indicates (fig. 155, 10) a "peristomial plate" which is finely ciliate along its free edge; while Hickson (fig. 59), referring to the peristomial excavation, says, "a thin vertical fold projects into this cavity on

the right side (left in the figure), and a thicker striated fold projects into it on the left side." In my specimens I was not able to make out this vertical fold on the right side, though there was a distinct flap along the left border of the peristomial field, and this flap bore fine cilia along its free edge in the prominent anterior portion only. The cavity of the peristome is the entire area enclosed between the two cross striated lines curving backwards from the anterior margin of the body, and not merely the space enclosed between the so-called peristomial bands (represented dark in the figure as reproduced by Hickson). It is unfortunate that in interpreting the figure and making the above observations relating to it I have not had access to the original monograph of Schuberg.

One specimen contained about forty or more small ciliate organisms very much like the supposed young ones observed by Stein. As observed by that writer the specimen was so full of these organisms that all trace of peristome was obliterated. The specimen after proper fixation showed a portion of the elongated band-like meganucleus. The existence of a band-like nucleus side by side with the presence of the ciliated organisms, according to Kent, "justifies a doubt as to whether or not the so-called embryos were parasitic organisms, and more especially since their further development into typical *Bursariæ* was not traced by Stein." I also was not able to trace their development, and so cannot settle this disputed point. In a second specimen in which ciliate organisms were present, owing to partial evaporation of water and consequent pressure of the cover-slip, the animal showed diffluence, and some of these ciliate organisms were extruded from its body. A portion of the body protoplasm also flowed out, but remained connected with the body by a thread-like connexion. On replenishing the water under the cover-slip a sort of regeneration took place; the cilia of the animal went on working for an hour, when it was a complete animal again, though much distorted in form.

#### Family STENTORINA Stein.

##### Genus *Stentor* Oken.

##### *Stentor polymorphus* Müller sp.

I have several times come across specimens of *Stentor* from small ponds near the River Ravi, and have seen them both singly and in the social condition. The specimens have always belonged to the colourless variety (*Stentor mülleri* of Ehrenberg). The presence of the moniliform nucleus, the absence of the gelatinous lorica, the hair-like bristles along the margins of the body, and the circlet of finer setæ at the posterior extremity enable it to be referred to *S. polymorphus*.

## HYPOTRICHA.

Family PLEUOTRICHINA Bütschli.

Genus *Stylonychia* Ehrbg.*Stylonychia pustulata* (O. F. M.) Ehrbg.

This form was met with in the stagnant water from a burrow-pit (*chaubacha*) close to the garden well in the Gol Bagh in December 1919, in association with *Bursaria truncatella*. The specimens were found in drops of water taken from the surface. The body was not flexible, it was broadest about the middle, almost equally wide in front and behind, and abruptly rounded at its posterior extremity. The peristome was triangular and did not extend to the middle of the body. The cilia were rendered distinct by treatment with weak alum solution, and it was observed that the frontal cirrhi were eight in number and arranged in the characteristic manner; ventral cirrhi were present, but not distinct, and their number could not be ascertained; the anal cirrhi were five in number, turned back, and projecting beyond the posterior end of the body. The marginal cilia were set within the border, and the row was interrupted at the posterior end by the three caudal styles characteristic of the genus, but these were not very long. The macronucleus was central, consisting of two parts, oval in outline, and one part was partly overlying the other, no connecting thread being present.

The specimens examined differed chiefly from the form as figured by Kent (Plate XLV, fig. 17) in the marginal row of cilia being interrupted at the posterior end, and in the macronuclei being situated close together.

## GENERAL SUMMARY.

It is well known that the fresh-water Protozoa are mostly cosmopolitan in their distribution. It is therefore not at all surprising that although, as the result of work on ciliate Protozoa recorded in this and the previous papers (2, 3), the number of recorded species for India has been considerably increased, the number of species or forms new to science is very small. The total number of Ciliates recorded from India by Carter and other workers is 28. The number of species that have come under my observation is 41, practically all of which I have recorded from India for the first time, only two of them—viz. *Coleps hirtus* and *Loxophyllum fasciola*—having been previously reported by the other workers. It is indeed remarkable that none of the other 28 recorded by other workers should have come under my observation, and that those observed by me—which include some very common and cosmopolitan forms, viz. species of the genera *Prorodon*, *Didinium*,

*Colpidium*, *Colpoda*, *Paramecium*, *Cyclidium*, *Spirostomum*, *Bursaria*, *Halteria*, *Stylonychia*, *Carchesium*, and *Epistylis*—should have escaped the attention of observers in other places in India. It is possible that the ciliate forms met with by Carter in Bombay are different from those so common in the Punjab; but I am pretty confident that a more extended study than that which I have been able to attempt, of forms met with in other parts of India, will not only confirm the existence of the above-mentioned genera in other parts, but also enable the record to be still further extended. Altogether 67 species of Ciliates have been so far recorded from India. They do not exhibit great variety of forms, as a rule, each genus being represented by one or two species only. Thus these 67 species belong to as many as 44 different genera, and almost all the important families have their representatives in India.

Schewiakoff (26), after an elaborate study of the distribution of fresh-water Protozoa, showed that a very high percentage of the genera and species found in other countries are identical with those met with in Europe. The following remarks are worth quoting:—

“Of the 182 species (belonging to 91 different genera) observed in countries outside of Europe, 79 genera and 145 species have already been met with in Europe, so that the number of new extra-European forms—i.e. forms not yet found in Europe (12 genera and 37 species)—is relatively quite insignificant. The total number of Ciliates as yet known to occur in Europe amounts to 105 genera and 236 species. Comparison of these with the number of European forms observed outside Europe shows that over three-quarters (75·2 p.c.) of the European genera, and over three-fifths (61·4 p.c.) of the European species, have already been shown to occur outside Europe. This percentage, which is considerably greater than that attained in any other class of Protozoa, indicates—setting aside the circumstance that the fresh-water Ciliates have been studied outside Europe in greater detail than any other Protozoa—that a very large number of European ciliates enjoy an extended distribution. Furthermore, the conclusion may be drawn that the conception of a universal distribution remains valid even when applied to the most highly organized of the Protozoa.”

After surveying the geographical distribution of the various Protozoan groups, he came to the following further conclusion:—

“All these conclusions lead to the final result that we are quite unjustified in speaking of a ‘geographical distribution’ of the fresh-water Protozoa, in the sense in which we apply the term to higher animals and plants; but they must, on the contrary, have a distribution which is ubiquitous, or universal.”

So far as the facts of geographical distribution are concerned my work only confirms the foregoing conclusions. Of the 41 species studied by me as many as 38 are such as have been described

from Europe or America before. They generally present certain differences in size or other minor details of structure, but pending further and more intensive study of the life-history of these forms it has not been deemed advisable to establish a large number of them as new species.

SUPPLEMENTARY TABLE OF INDIAN SPECIES OF CILIATA.\*

SPECIES	Recorded from India by other Writers	Found and recorded by the Author
<i>Prorodon edentatus</i> Cl. & Lachm. . . . .	—	+
<i>Coleps kenti</i> sp. n. . . . .	—	+
„ <i>uncinatus</i> Cl. & Lachm. . . . .	—	+
<i>Didinium balbianii</i> Bütsch. . . . .	—	+
<i>Dileptus gigas</i> (Cl. & Lachm.) Wrzesn. . . . .	—	+
<i>Chilodon steini</i> Blochm. . . . .	—	+
<i>Cyclidium glaucoma</i> Ehrbg. . . . .	—	+
<i>Bursaria truncatella</i> O. F. M. . . . .	—	+
<i>Stentor polymorphus</i> O. F. M. . . . .	—	+
<i>Stylonychia pustulata</i> (O. F. M.) Ehrbg. . . . .	—	+

\* *Vide* Journ. Roy. Micro. Soc., 1920, p. 266.

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#### IV.—CONTRIBUTIONS TO THE HISTOLOGY OF THE THREE-TOED SLOTH (BRADYPUS TRIDACTYLUS).

By CHARLES F. SONNTAG, M.D., F.Z.S., F.R.M.S., Anatomist to the Zoological Society of London; and F. MARTIN DUNCAN, F.R.P.S., F.Z.S., F.R.M.S.

(Read June 15, 1921.)

THIRTEEN TEXT-FIGURES.

THE materials on which the present paper is based consisted of the hairs and tissues of an adult female *Bradypus tridactylus* which died in the Zoological Society's Gardens. The sections were prepared by the usual paraffin method, and stained with hæmatoxylin and acid eosin.

One of us (C. F. S.) has already described the macroscopic appearances of the organs.\*

##### THE TONGUE (text-fig. 1).

The histological characters show that the mechanical functions predominate over the sensory ones.

The conical papillæ are small and discrete. They have a thick epithelial covering which is drawn out into one or more sharp points directed backwards and inwards. The fungiform papillæ are flat, circular and scanty; they have few taste-buds, but sensory nerve-endings are present. The two circumvallate papillæ are smooth and glistening, and are conical on elevation with the bases of the cones projecting beyond the well-marked annular vallums; and they can be powerfully retracted when irritated; lateral organs or foliate papillæ are absent. The gustatory organs are, therefore, few in numbers.

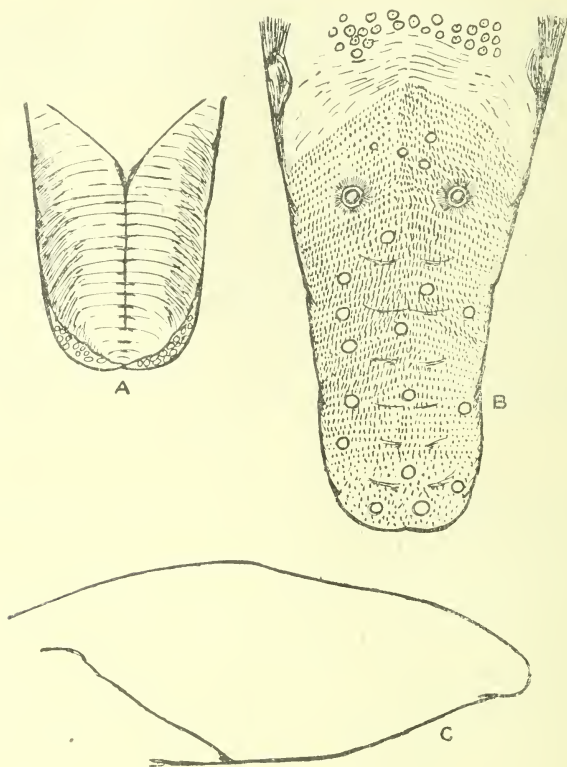
Serous and mucous glands are present as usual on the base of the tongue, but are not strongly developed, and they are accompanied by a few lymphoid nodules. The diminution in the glandular apparatus is in keeping with the reduction in the gustatory organs. No apical gland of Nuhn is present.

\* "A Contribution to the Anatomy of the Three-toed Sloth," Proc. Zool. Soc., London, 1921, pp. 157-77. In this paper there are photographs of the various parts of the stomach, whose histology is described below.

## THE PALATE, MOUTH AND ŒSOPHAGUS.

The papillæ on the mucosa of the palate are greatly enlarged to form a series of large tubercles which have already been described and figured,\* and the epithelium contains pigment granules.

The oral epithelium contains many glands.



TEXT-FIG. 1.—THE TONGUE. A, upper surface; B, inferior surface, C, side view. Figure reproduced by permission of the Zoological Society.

The stratified epithelium of the œsophagus is continuous with the lining of three of the compartments of the complex stomach. The muscular coat consists of three layers, of which the middle one is of circular and the inner and outer ones are of longitudinal fibres.

\* See note on p. 37.

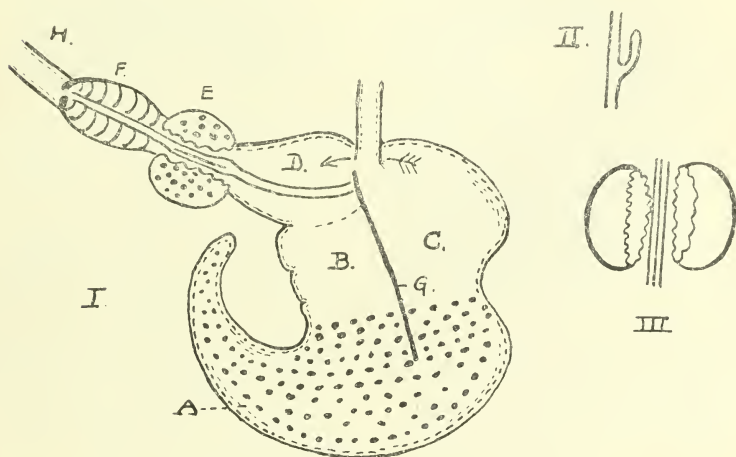
## THE STOMACH (text-fig. 2).

The complex stomach is divided into three groups of compartments, and the histological characters show that some have a secretory function, but the others are purely mechanical. The compartments are :—

1. The paunch (A) with a conical caecal appendix.  
2. The cardiac stomach derived from the œsophagus and divided into three compartments (B, C, D).

3. The U-shaped pylorus consisting of two tubular parts (E, F).  
Two of the compartments of the cardiac stomach are separated by a septum (G) which runs into the paunch for a short distance.

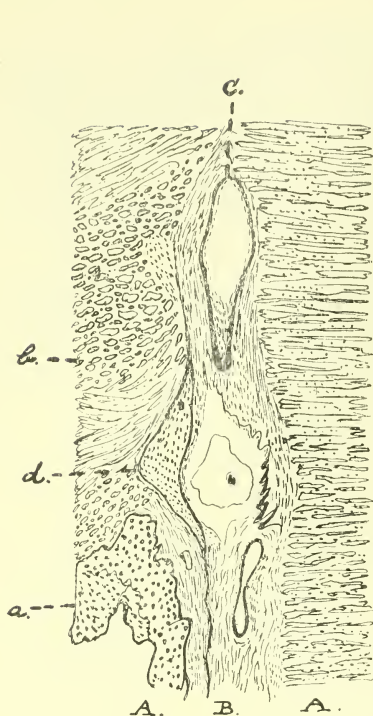
*Histology.*—When a section is made through the septum (G)



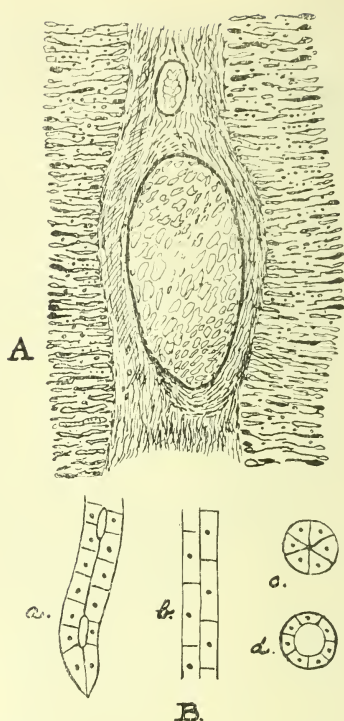
TEXT-FIG. 2.—THE STOMACH. I., divisions; II., view of a fold of the mucosa; III., longitudinal folds running between glandular masses in the first part of the pylorus; H., duodenum. Other letters in text.

at the point where it passes into the paunch, one sees the stratified epithelium of the cardiac stomach (*a*) giving way to the glandular epithelium of the paunch (*b*) (text-fig. 3); and the change resembles that of the gastro-œsophageal junction of a simple stomach. The transition is a sharp one, but does not take place at the same level on each side of the septum. The corium contains lax connective tissue, capacious blood-vessels (*c*), and aggregations of lymphoid cells (*d*). The muscular coats are diminished.

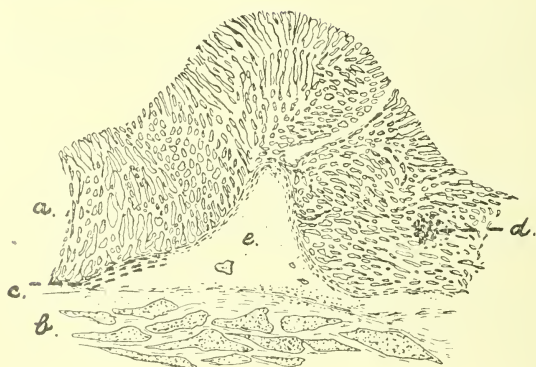
The mucosa of the paunch (text-fig. 4) is succulent, pitted by innumerable glandular orifices and thrown into folds. A section



TEXT-FIG. 3.—Section through the septum running from the cardiac stomach to the paunch. AA, glar-dular layers; B, corium of the septum. Other letters in text.

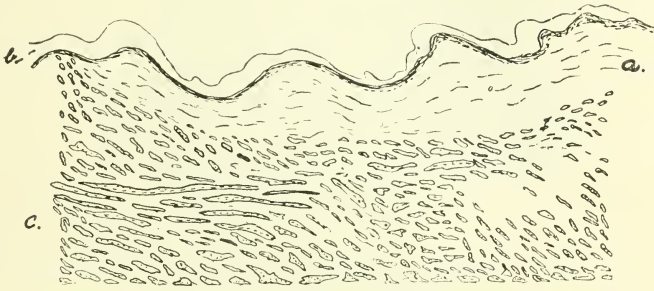


TEXT-FIG. 4.—Structure of the paunch. A, section through a fold of the mucosa; B, the glands in longitudinal (a, b) and transverse section.



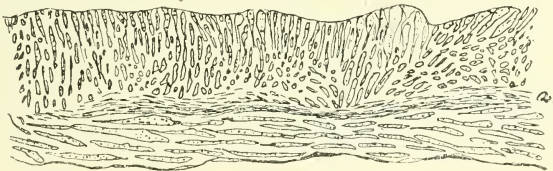
TEXT-FIG. 5.—Section through the caecal appendage of the stomach. e, core of a ruga. Other letters in text.

across a fold exhibits two strata of glands separated by a corium containing capacious thin-walled blood-vessels, and muscular and elastic tissues. The glands are cut through in different planes, and appear as rods of cells, long ducts or circles according to the plane of section. The cubical gland cells have many granules, and their nuclei take on chromatin dyes very intensely. Some of the gland tubes are simple, but others are bifurcated, and they abut against a well-marked muscularis mucosæ.



TEXT-FIG. 6.—Structure of the cardiac stomach. *a*, mucous membrane; *b*, stratum corneum; *c*, muscular coat.

The *cæcal appendage* (text-fig. 5) is long and tapering, and its lumen is bisected by a septum in the upper part. In the greater part of its length the mucosa is thrown into six longitudinal folds. Its glands (*a*) resemble those in the paunch, and its muscularis mucosæ (*c*) is likewise well developed. The muscular coat (*b*) is



TEXT-FIG. 7.—Structure of the pyloric glandular region (fig. 2, E).

strong and sends processes into the core of the rugæ. The remainder of the extra-muscular layer contains much connective tissue and many thin-walled blood-vessels. Lying among the glands are aggregated lymphoid cells (*d*).

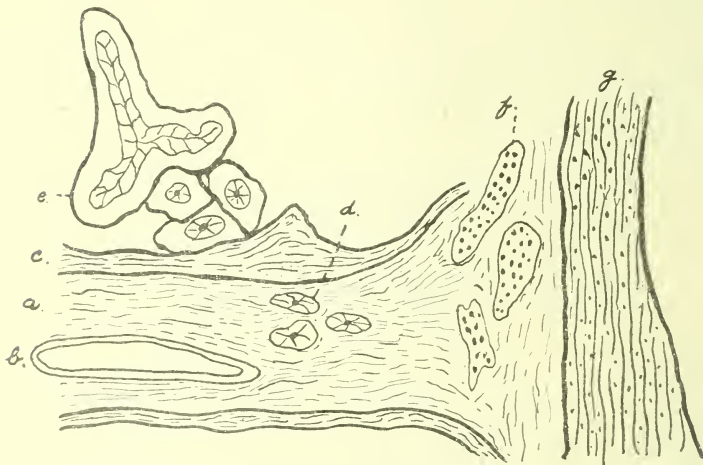
The *cardiac stomach* (text-fig. 6), which is derived from the œsophagus, is divided into three compartments, whose histological characters differ. But in all the submucous connective tissue (*a*) is loose and thick. The epithelial layers, especially the superficial

ones, vary in thickness, and in some parts the stratum corneum (*b*) is thicker than the rest of the mucous membrane. The cells



TEXT-FIG. 8.—Structure of the pyloric muscular region (fig. 2, F).  
Letters in text.

of the stratum mucosum and stratum germinativum stain very deeply. No glands are present in the cardiac stomach.



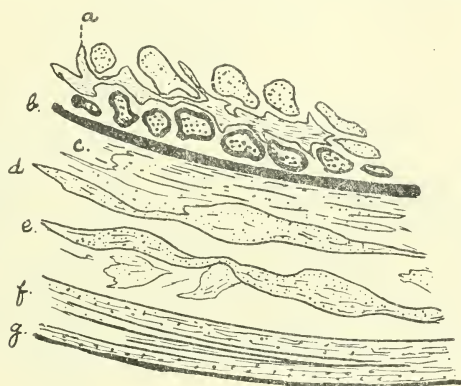
TEXT-FIG. 9.—Section through an intestinal villus. *f*, lymphoid nodules; *g*, muscular coat. Other letters in text.

The *pyloric glandular region* (text-fig. 7) has a central gutter running along the floor, and stout folds of the mucosa traverse its entire length. It is bordered by two hard white ridges composed

of a much pleated corium covered with thick epithelium. The glandular areas lie external to these ridges, and their cylindrical cells have small round nuclei which stain intensely. And, as in other glandular parts of the stomach, the muscularis mucosæ (*a*) is well developed.

The muscular part of the pylorus (text-fig. 8) has very thick walls. Its stratified epithelium (*a*) forms a thick rugose layer. The submucous tissue (*b*) is well developed, and the muscular coat (*c*) is stronger than in any other part of the stomach. Rapp suggested that this part of the stomach exerts an action on the hard food similar to that of the gizzard of a bird.

The muscular coat forms a powerful sphincter, but some anatomical works deny that there is such a muscle.



TEXT-FIG. 10.—Structure of a non-rugose part of the small intestine.  
*b*, muscularis mucosæ; *c*, connective tissue; *d-g*, muscles.

### THE INTESTINES.

The *duodenum* has well-marked Brunner's glands, and the mucosa is thrown into a number of folds, which are more numerous at the distal end.

Peyer's patches are absent, but the mucous membrane of the entire length of the small intestine contains many small clusters of lymphoid nodules.

The ileum and jejunum exhibit alternate rugose and comparatively smooth areas.

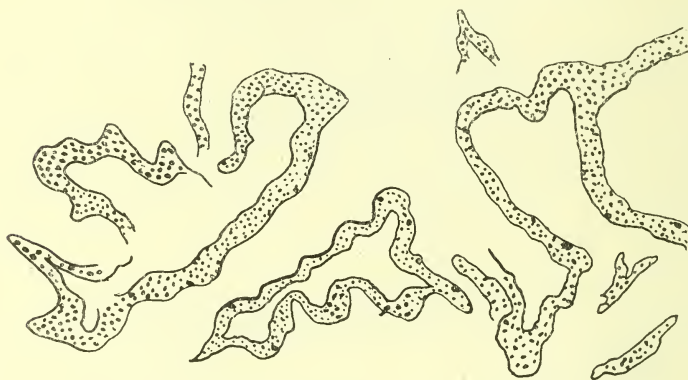
In the rugose parts (text-fig. 9) the glands form a thick covering over a moderately thick core (*a*), in which the connective tissue is loose, and the blood-vessels (*b*) are thin walled and capacious. Between the glands and core is a well-developed muscularis mucosæ (*c*). In some parts there are a few small glands (*d*) outside the muscularis mucosæ, and these are similar in position to

Brunner's glands. The glands of Lieberkühn are cut in different planes, and lie within spaces formed by connective tissue bands. In the non-rugose parts (text-fig. 10) the connective tissue forms finger-like or club-shaped processes (*a*), surrounding large spaces, at the periphery. The muscular coat is well developed, and has the usual longitudinal and circular layers, and the former is a complete layer. The blood-vessels are wide and thin walled.

The most characteristic feature of the large intestine, whose absorptive and digestive functions reach a high degree, is the presence of large blood-vessels between the glands and muscularis mucosæ.

It appears, therefore, that the characteristic features of the gastro-intestinal tract are:—

1. The large amount of connective tissue.



TEXT-FIG. 11.—Section through the lung showing three alveoli, constituting an entire field when examined through a  $\frac{1}{6}$ th objective and  $\times 10$  eyepiece.

2. The glands are highly developed and the entire intestinal tract is short.
3. The muscularis mucosæ is well developed everywhere.
4. The blood-vessels are wide and thin walled.
5. The histological characters of the mechanical and glandular areas are very different.
6. The duodenum is not the only part where glands are found outside the muscularis mucosæ.
7. Lymphoid cells form aggregations in the mucosa of the stomach and intestines.

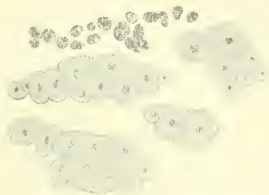
The histology of the liver and pancreas are described in my paper mentioned in the foot-note on p. 37.

# THE ORGANS OF RESPIRATION.

The sloth lives a sluggish life in hot climates, so there is no necessity to warm the air during the process of respiration.

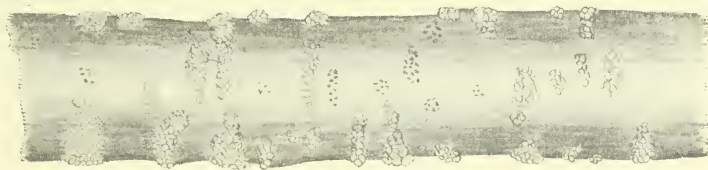
The *larynx* is lined by cubical cells, but the vocal cords are clothed with stratified epithelium.

The *pulmonary alveoli* (text-fig. 11) are large, so the preparation of satisfactory sections is a matter of considerable difficulty. Many of the sacs intercommunicate, but I believe that the septa



TEXT-FIG. 12.—Algae on the hairs. The large ones are green, and the small ones are pink.

have been broken down in the process of preparation. In some parts fewer than twelve alveoli fill the field. They vary greatly in shape, but the majority are long, narrow and irregular, or small and circular according to the plane of section. They are lined by large cubical cells containing one or more nuclei, and possessing granular protoplasm. Their blood-vessels are thin walled and capacious, and some, which are cut longitudinally, appear as irregular tubes packed with red blood corpuscles.



TEXT-FIG. 13.—A hair-shaft with algae.

The *bronchi* have well-developed muscular coats, and there is a large amount of connective and elastic tissue around them.

The appearance of a section through the lung of the sloth is very like that of vesicular emphysema in man.

## ON THE MICROSCOPIC STRUCTURE OF THE HAIR OF *BRADYPUS TRIDACTYLUS*.

(Text-figs. 12 and 13.)

The body of *B. tridactylus* is clothed with long, stout, somewhat brittle hairs forming the "outer" coat, and finer, soft, short "fur"

hairs constituting the under-coat. In the living animal, and in freshly captured specimens, the long hairs have a greenish hue, which has been observed to fade in the process of drying and preserving the felt. This greenish tint is due to the presence of large colonies of minute algæ growing on the stout, long hairs. Under the microscope these hairs are seen to possess elongated scales which lie singly, overlapping the hair-shaft (elongate type of imbricate scale), and it is in the crevices of these scales that the minute algæ find lodgment. The long hairs average about  $\frac{1}{100}$ th of an inch in diameter, and have a well-marked continuous medulla about three  $\frac{1}{1000}$ ths of an inch in diameter.

The unicellular algæ which form colonies between the scales of the hair-shaft are probably closely allied to *Protococcus viridis* (*Pleurococcus vulgaris*), and are bright green in colour; the largest cells averaging  $\frac{1}{2000}$ th of an inch in diameter, and having a large, more or less central nucleus. Bipartition takes place by the formation of a partition wall, which cuts the cell in halves. This is the predominant type of alga, but, in addition, colonies of a smaller form, averaging in the largest cells  $\frac{1}{4000}$ th of an inch in diameter, are present in isolated patches, scattered at intervals among the scales of the hair-shaft. It is the presence in lesser numbers of these pink colonies that serves to partially mask the bright green of the larger forms, giving to the hair, as seen by the naked eye, a dull greyish-green hue.

SUMMARY OF CURRENT RESEARCHES  
RELATING TO  
ZOOLOGY AND BOTANY  
(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),  
MICROSCOPY, Etc.\*

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ZOOLOGY.

V E R T E B R A T A.

*a.* Embryology, Evolution, Heredity, Reproduction,  
and Allied Subjects.

**Spermatogenesis of Opossum.**—THEOPHILUS S. PAINTER (*Journ. Exp. Zool.*, 1922, **35**, 13-38, 3 pls., 8 figs.). There are 22 chromosomes in the spermatogonia of *Didelphys virginiana*. The two smallest of these constitute a typical X-Y sex-chromosome complex, which can be followed through the growth period of the first spermatocyte. In the first maturation spindle there are 11 chromosomes—10 tetrads and the X-Y chromosome. The X and Y components segregate from each other in this division so that the secondary spermatocytes contain either 10 autosomes plus X, or 10 autosomes plus Y. There are 11 chromosomes in all secondary spermatocytes; one of these is either the X-component or the Y-component. In either case the sex-chromosome divides equationally. Half the sperms carry the X-chromosome and half the Y-chromosome. A study of dividing somatic cells of embryos showed that in both males and females 22 chromosomes were present. In the males the X-Y condition was found, in the females the 2-Y condition.

J. A. T.

**Persistent Spermatogenetic Activity in Man.**—P. LECÈNE (*Comptes Rendus Soc. Biol.*, 1920, **83**, 830-1, 1 fig.). In two cases of 72 and 78 years the seminiferous tubules showed active spermatogenesis, and there were spermatozoa in the lumen. In a case of 67 years, however, the spermatogenesis had disappeared completely, and the seminiferous tubules had thick walls, with undifferentiated vesicular cells showing inactive nuclei. In all three cases the interstitial cells of

\* The Society does not hold itself responsible for the views of the authors of the papers abstracted. The object of this part of the Journal is to present a summary of the papers as *actually published*, and to describe and illustrate Instruments, Apparatus, etc., which are either new or have not been previously described in this country.

the testis showed a considerable degree of development. Mott has recently reported active spermatogenesis in two men of 81 and 86 years of age. It does not seem as if age itself was sufficient to account for arrest of spermatogenesis and atrophic sclerosis of the testis. J. A. T.

**Fecundity of Fowls.**—RAYMOND PEARL and W. F. SCHOPPE (*Journ. Exper. Zool.*, 1921, **34**, 101-18, 2 figs.). The functioning ovary when taken from the bird closely resembles a bunch of grapes. It is made up of a large number of oocytes held together by connective tissue, joined to a heavy stalk by which they are kept in place in the body. In counting the oocytes four groups were distinguished—(a) follicles from which the ova had been discharged, which ought to conform closely to the total number of eggs laid; (b) oocytes over 1 cm. in diameter; (c) those over 1 mm. and under 1 cm.; and (d) those under 1 mm. Thirty-six birds were studied, including various breeds of domestic fowls, water-fowl, and wild birds. In general, the mean number of visible oocytes on the ovary in different kinds of birds reflects the normal fecundity or laying activity of these kinds of birds. This relation does not hold with any exactness or regularity for differences in fecundity between individual birds. In Barred Plymouth Rock fowls the number of visible oocytes increases with advancing age of the bird, within the age limits of 6 months and 37 months. It is probable that the oldest of the birds counted was not old enough to have reached the limit of ovarian rest. By removing a portion of the ovary and causing it to regenerate, the total number of oocytes developing to visible size in the lifetime of the bird was caused to increase from 33 to 68 p.c. over the number which develop in the normal bird which has not been operated on. J. A. T.

**Development of Supra-renal Capsule in Hedgehog.**—A. CELESTINO DA COSTA (*Comptes Rendus Soc. Biol.*, 1920, **83**, 878-9). At an early 6 mm. stage the inter-renal primordium is distinct, and closely bound up with the genital primordium. The first traces of the sympathetic are seen at the stage of about 5 mm., and the penetration of sympathetic elements into the inter-renal primordium comes about very early—at the 8 mm. stage. J. A. T.

**Transformation of Bidder's Organ into an Ovary.**—W. HARMS (*Zool. Anzeig.*, 1921, **53**, 253-65, 8 figs.). From male toads showing a tendency to form ova in Bidder's organ, testes were removed and the wounds closed up. The result was that Bidder's organ turned in part into an ovary. It follows that a certain percentage of toads are hermaphrodites. It is well known that all have at least a residue of oviducts (uteri masculini). What the experiments showed was that the removal of the testes increases the potential femaleness. In some cases the ovary which developed from Bidder's organ was large and the uteri masculini were much stronger than usual. But in other respects the animals remained males. J. A. T.

**Influence of Hypophysis on Pigmentation of Anuran Larvæ.**—W. W. SWINGLE (*Journ. Exper. Zool.*, 1921, **34**, 119-41, 2 pls., 4 figs.). By transplantation experiments it has been shown that in frog larvæ

the pars intermedia of the hypophysis secretes a substance which has a profound effect on the melanophores. The absence of the hormone results in permanent contraction of many of these cells, and expansion of the xantholeucophores. Its presence in large quantities, such as follows the transplantation of the glandular tissue, causes maximum expansion of the epidermal and corial pigment-cells and contraction of the bearers of guanin and xanthin. The hormone of the pars intermedia of the hypophysis is an internal regulating agent of high potency, the effects of which are continuous, and not to any extent influenced by changes in the environment. It is probable that in the experiments the hormone acts directly upon the melanophores themselves by way of the blood stream, and not through the intermediation of the nervous system. But the second possibility is not ruled out. J. A. T.

#### b. Histology.

**Development of Hepatic Cell in Hedgehog.**—P. ROBERTO CHAVES (*Comptes Rendus Soc. Biol.*, 1920, **83**, 879–81). There is a series of ontogenetic transformations in the hepatic cell. During embryonic life the cell becomes vacuolated, increases in volume, and becomes loaded with fat which disappears in the later phases. The chondriosomes, at first very small, are transformed into rodlets and larger granulations. The vacuoles flow together and increase in size, forming a secretory product which is probably expelled when the digestive processes begin. It disappears in the sucking mammal. After birth the transformations continue, and those of the chondriosomes are remarkable. The fat reappears in connexion with lactation. J. A. T.

**Paranucleus of Pancreatic Cell.**—P. ROBERTO CHAVES (*Comptes Rendus Soc. Biol.*, 1920, **83**, 881–4). Some paranuclei are artefacts, but others are real. In the pancreatic cells of the hedgehog there is a migration of nucleoli from the nucleus. In the cytoplasm they begin to exfoliate, forming one or two or many enveloping lamellæ. They seem eventually to dissolve in the cytoplasm. J. A. T.

**Structure of Fused Bones of Frog.**—SUNDER LAL HORA (*Records Indian Museum*, 1920, **19**, 183–4). In the tibio-fibula of *Rana tigrina* the bony substance in the middle where the two bones are fused shows a regular system of canals instead of the usual compact structure of superimposed thin lamellæ. Seen under the microscope, this canalicular system appears identical with the Haversian canal system in the bones of higher Vertebrates. Sections of other fusions, e.g. between the radius and ulna, showed a similar system of canals. J. A. T.

#### c. General.

**Blood Vascular System of Sphenodon.**—CHAS. H. O'DONOGHUE (*Phil. Trans. Roy. Soc. London*, 1920, **210**, 175–252, 3 pls.). The heart is on the whole reptilian, but of a simple unspecialized type, in which the three main arterial vessels, instead of opening directly from the ventricle, come off by a short common trunk, possibly a remains of

the conus arteriosus. The arterial system in general is distinctly reptilian, and while in some respects it may recall conditions in other orders of reptiles, it most closely resembles that of certain Lacertilians, but it is undoubtedly less specialized, and shows certain interesting points of similarity with that of the Urodeles. The same general remarks also apply to the veins, which are more primitive than those of Lacertilia, though nearer to the latter than to the other reptiles. Looked at broadly the blood vascular system of the Tuatara is much more primitive than that of any other reptile so far described, and differs from even the Lacertilia so markedly that a separate order (Rhynchocephalia) is thoroughly justified. J. A. T.

**Aortic Ligament in Indian Fishes.**—D. R. BHATTACHARYA (*Proc. Zoo. Soc.*, 1920, Plates I–II, and 5 figs.). Existence of a longitudinal ligament inside the aorta and extending over its entire length, first noted in the Siluroid fish, *Pseudeutropius garua*. Observations on the dorsal aorta in over eighty species of fishes, both marine and fresh-water, are recorded. The disposition and attachments of the ligament, as also the histology of the structure, are carefully described. The ligament is a white flat sheet of elastic tissue, supported by regularly arranged white rounded masses of connective tissue which occur beneath the body of each vertebra, and fit into a depression on the ventral side of the centrum, acquiring a strong attachment with the connective tissue of the vertebral column. The structure is confined to some of the Teleost fishes alone, being absent in other groups of Vertebrata, and even among the Teleostomes it seems to be more of a generic feature than of a family one. It is suggested that the ligament acts as a longitudinal valve preventing forward regurgitation of blood. B. L. B.

**Glands of Oviduct in Tortoise.**—R. ARGAUD (*Comptes Rendus Soc. Biol.*, 1920, 83, 828–9). There is a two-fold glandular development in the oviduct of *Cistudo europæa*. There are mucinogenous unicellular glands arising from the temporary transformation of ciliated cells. There are also definitive glands, with ramified tubes, whose very granular cells appear only at the time of reproductive maturity. Their rôle seems to be to secrete protective membranes around the ovum. In young specimens there is no glandular differentiation at all. J. A. T.

**Occasional Absence of Paired Fins in Fishes.**—SUNDER LAL HORA (*Records Indian Museum*, 1921, 22, 27–32, 2 figs.). Description of a specimen of *Barilius barila* in which both the ventral fins were absent, without any hint of injury. In *Barilius dogarsinghi* the ventral fin of the left side was absent. In *Nemachilus kangjupkhulensis* the ventral fin of the right side was lacking, and the other was abnormal. In *Rita rita* the pectoral fin of the right side was absent, the musculature was degenerate, and the shoulder girdle was abnormal. In no case was there trace of injury, and the peculiarities may be interpreted as mutations or as due to some injury to the embryonic primordia. Attention is directed to two Indian genera of fresh-water fishes, *Channa* and *Apua*, which are distinguished from their nearest relatives by the absence of the ventral fins. J. A. T.

## Tunicata.

**Heart Activity in Ascidia.**—EDWARD C. DAY (*Journ. Exper. Zool.*, 1921, **34**, 45–65). There is a certain normal activity of the heart in *Ascidia mentula*, in which the number of beats is twenty-five for both ventral and dorsal series. The initial rate is 5.5 seconds per beat, and the pauses between the series average about 13 seconds. Stimulation, such as slicing pieces off the tunic, severing the nerves between ganglion and heart, and extirpating the ganglion, causes the number of beats to increase from twenty-five to fifty or ninety, the rate to drop from 5.5 to 5 or 4.5 seconds per beat, indicating acceleration, and the pauses to shorten from 13 to 10 or 8 seconds. In addition to these changes there is a retardation of the beat which manifests itself near the middle of a series. These changes go hand in hand with one another, and when any one of them is patently present, the others are present too. Exceptions occur in cases where the circulation has been interfered with through operation on the ganglion. The effects of stimulation abate and disappear in the course of an hour or a day, depending on the character of the operation, and the beat of the heart again exhibits its original normal characteristics. J. A. T.

**Reproductive Organs of Kükenthalia borealis.**—AUGUSTA ÄRNBÄCK CHRISTIE-LINDE (*Proc. Zool. Soc.*, 1921, 187–96, 8 figs.). It is shown that testes and ovaries, supposed to be absent, occur in this compound Ascidian. The male organs, as well as the ovary and the ducts, are enclosed in a long, sac-like outgrowth of the mantle which extends into the common test. At the upper side of this sac there is sometimes another sac-like structure, evidently a brood-pouch. It may be a direct projection from the peribranchial cavity, or it may be formed in connexion with the oviduct. Apart from the gonads there are sometimes isolated eggs in the mesoderm, and also in buds which grow out on both sides of the parent animal. J. A. T.

**Genus Atopogaster.**—R. HARTMEYER (*Zool. Anzeig.*, 1921, **53**, 273–81). Among the Synoicidae, with smooth or longitudinally-folded stomach wall, Herdman established the genus *Atopogaster* for forms with a transversely-folded wall. He doubted, however, if the five species of the genus formed a natural group. According to Hartmeyer, the transverse folding cannot be upheld and the five species are heterogeneous. Two should be referred to *Amouroucium fugiense*, another is an *Aplidium*, and the two other are referable to the genus *Polycitor*. J. A. T.

## INVERTEBRATA.

## Mollusca.

## γ. Gastropoda.

**New Pelagic Nudibranch.**—KRISTINE BONNEVIE (*Zool. Anzeig.*, 1921, **53**, 145–52, 5 figs.). In "Michael Sars" material from the North Atlantic there occurred along with *Glaucus* and *Phyllirhœ* an altogether new type, *Dactylopus michaelisarsii* g. et sp. n., which seems

to require a new family of Nudibranch Opisthobranchia. That it is an Opisthobranch is shown by the right-side position of the kidney opening and of the separate genital ducts, and by the hermaphrodite organ. That it is a Nudibranch is indicated by the strong concentration of the central nervous system with the ganglia mainly dorsal, and by the relatively long pedal commissure, as also by the complete absence of a shell. A remarkable feature is the finger-shaped foot. So is the presence of a large transparent caecum arising from the stomach, perhaps respiratory or hydrostatic in function. The body is laterally compressed, there are no eyes or tentacles, the radula is rudimentary or absent. Only one specimen was obtained. It has only convergent resemblances to *Phyllirhœ*. J. A. T.

**Victorian Chitons.**—EDWIN ASHBY (*Proc. Roy. Soc. Victoria*, 1921, 33, 149-58, 1 pl.). Description of *Rhyssoplax jacksonensis* sp. n., *Lepidopleurus iredalei* sp. n., and a number of other forms. J. A. T.

### Arthropoda.

#### a. Insecta.

**Persistence of Traces of Wings in Worker Ants.**—HARLOW SHAPLEY (*Proc. Nat. Acad. Sci.*, 1921, 6, 687-90). The embryonic vestiges of wings discovered by Dewitz in workers of *Formica* do not invariably disappear with the passing of larval and pupal stages, but occasionally persist to the adult state. Wheeler has called such winged workers "pterergates," and nine cases have been recorded as rarities. From a nest of the red Californian Harvester, however, Shapley has taken during two years more than 1700 workers, nearly one half of which showed vestigial wings in various stages of development. This suggested that Mendelian factors might be involved in the appearance of wings. There was no obvious external reason why the nest in question should show the peculiarity. In fifty colonies within a radius of two miles only one pterergate was found. In all details of thoracic structure the pterergates agree with normal ergates, and they participate equally in excavating and guarding the nest and in harvesting. The seventeen young queens and two males taken from the nest were quite normal. Of the 740 pterergates, 385 showed minute veinless wing-sacs or stubs of broken wings; 219 showed sacs from 0.5-1 mm. in length with indistinct veining; and 132 had transparent, clearly veined winglets from 0.8 to 1.5 mm. long. The gradation is perfectly continuous, which may be of interest in connexion with the origin of castes. Four ants from the affected nest had vestiges of both posterior and anterior wings. In all other cases only anterior wings were represented.

J. A. T.

**Thermokinetics of an Ant.**—HARLOW SHAPLEY (*Proc. Nat. Acad. Sci.*, 1920, 6, 204-11). From the measurement of the speed of a thousand individuals of the ant *Liometopum apiculatum*, an empirical curve was obtained that for any temperature throughout a range of 30° C. gives the speed with an average probable error of 5 p.c. for one observation. Conversely, from a single observation of the ant-speed,

the temperature can be predicted within  $1^{\circ}\text{C}$ . The activity is less erratic for higher temperatures and the percentage probable error decreases. As the temperature rises to  $30^{\circ}\text{C}$ . the speed changes fifteen fold, increasing uniformly from 0.44 to 6.60 cm. a second. For a large Eciton at a nominal speed of 7.6 cm. a second is recorded by Beebe and on a later occasion a speed of 15.2 cm. a second. There appears to be little, if any, real difference in speed towards and away from the nest. Large and small workers have practically the same speed for all temperatures during the summer months; after two months of low temperature the large workers are conspicuously more active than the small workers. In the case of *Liometopum* the numbers on the run are as great at night as during the day. Maximum activity falls between noon and midnight. Within the limits of  $14^{\circ}$  and  $38^{\circ}\text{C}$ ., temperature seems to have little effect on the numbers running in the files.

J. A. T.

**Larvæ of Cavernicolous Trechini.**—R. JEANNEL (*Arch. Zool. Exper.*, 1920, 59, 509–42, 62 figs.). An account of the larvæ of numerous species of cavernicolous beetles in the family Trechini. They are delicate, with little chitin, with ocelli absent or reduced to two or three pigmented patches, and with elongated and delicate mouth parts. There is a general but not an absolute correlation between the disappearance of the eye and the elongation of the appendages. When the adult has eyes the larva has ocelli; when the adult is blind the larva has no ocelli. In *Trechus brevili* the retrogression of the eye has gone further in the larva than in the adult, for the larva is quite blind, while the adult has small eyes still functional. The simpler the organ, the easier is its atrophic retrogression.

J. A. T.

**New Aleocharinæ and New Classification of Types.**—ADALBERT FENYES (*Bull. Mus. Comp. Zool. Harvard*, 1921, 65, 17–36). Descriptions of numerous new species and genera of these beetles and a discussion of the classification of the tribes of Aleocharinæ. What is proposed is held to offer several advantages over former systems—viz. *order* (the tribal characters being arranged in mathematical *progression*), *simplicity* (not more than four characters being used for the definition of the tribes), *uniformity* (the same four characters being employed throughout the key), and *reliability* (the four characters utilized being absolute, i.e. expressed in numbers, not relative or comparative). The characters used are the tarsal joints, the antennary joints, the maxillary palps, and the labial palps.

J. A. T.

**New Australian Tabanids.**—E. W. FERGUSON (*Proc. Roy. Soc. Victoria*, 1921, 33, 1–29, 2 pls., 4 figs.). Descriptions of numerous species, new and old, notably in the hairy-eyed group of *Tabanus*. The Australian Tabanid fauna has been derived from two sources—(1) Malayan, from which come species belonging to *Corizoneura*, *Silvius* and *Tabanus* (excluding the hairy-eyed group); and (2) Antarctic, from which source have probably been derived the Southern Tabanids, including the genera *Diatomineura*, *Erephopsis*, *Pelecorrhynchus*, and the hairy-eyed group of *Tabanus* (*Therioplectes*).

J. A. T.

**Dipterous Larvæ Feeding on Molluscs.**—D. KEILIN (*Parasitology*, 1921, 13, 180–3). In a previous paper the author described a case of

the larvæ of a Calliphorine fly, *Melinda cognata*, living as parasites in a snail (*Helicella virgata*). The fly has often been observed depositing its eggs on the snail. Similar cases are now brought together—larvæ of *Sarcophaga filia* devouring small snails; *S. melanura* depositing its larvæ on a slug (*Arion fuscus*); *Engyrops pecchiolii* probably living as a larva on snails; *Lucilia dux* and *Pycnosoma* on Indian forms of *Achatina*; *Sciomyza dubia* as pupæ in *Vitrea* and other snails; and various Phoridae found as inhabitants of dead snails. J. A. T.

**Peculiar Cells in Fat-body of Flies.**—ELFRIEDE HERRMANN (*Zool. Anzeig.*, 1921, 52, 193–200, 3 figs.). In some specimens of *Musca domestica*, *Calliphora* and *Lucilia*, but not in all, there are white spheres and ellipses, with a firm envelope, coarsely granular cytoplasm, and large nucleus. Their occurrence seems to be independent of species, season, age, sex and nutritive condition. They are formed in the fat-body or from some of its cells. They are very probably reserve elements. The larger ones contain albumen, and the smallest glycogen. J. A. T.

**Fat-cells, Salivary Glands, and Malpighian Tubules in Tenthredinid Larvæ.**—EMIL WILKE (*Zool. Anzeig.*, 1921, 52, 249–54, 1 fig.). In larvæ of sawflies the fat-cells lie free, but they are connected by a cell-bridge so that a net is formed. The acini of the salivary glands bear a very close resemblance to the reticulum of fat-cells, and Wilke argues that the acini are transformed fat-cells. The transitional phases are remarkable. But the investigator goes further and holds the same to be true in regard to the Malpighian tubules. Again, there are the cell-bridges and the transitional forms between one kind of cell and another. J. A. T.

**Nephrocytes of *Pediculus hominis*.**—GEORGE H. F. NUTTALL and D. KEILIN (*Parasitology*, 1921, 13, 184–92, 5 figs.). There are in lice two groups of excretory-accumulatory cells known as nephrocytes. The one group, the peri-oesophageal, lies ventrally and consists of large cells aggregated usually in two masses about the oesophagus, anterior to the reniform salivary glands. The second group lies dorsally and consists of disseminated cell-aggregates linked with the fat-body. The typical nephrocyte is a binucleate cell with granular protoplasm containing greenish droplets of varying size. The excretory function is demonstrated by intra-cœlomic injection of ammonia-carminé. This is taken up by the nephrocytes twenty-four hours after injection, and the carminé granules remain in the protoplasm of the nephrocytes throughout the life of the louse. Similar cells occur in Mallophaga and have been wrongly described by some authors as salivary glands. The two groups of nephrocytes, seen in *Pediculus*, occur in other insects, but the dorsal group usually forms two chains of cells, known as pericardial cells, lying on either side of the heart. J. A. T.

**Philippine Termites.**—S. F. LIGHT (*Philippine Journ. Science*, 1921, 18, 243–57). Thirty-three species are recorded from the Philippines, belonging to nine genera. One genus, *Termitogetonella*, is known from the Philippines only; and the same may be said of twenty-three species. Among the thirty-three species from the islands the

adult is known for only twelve. It looks as if the queen and king must often be located in a well-hidden subterranean chamber. The question of classification is briefly discussed.

J. A. T.

**Insects Checking the Spread of Lantana in India.**—RAO SAHIB RAMACHANDRA RAO (*Mem. Dept. Agric. India*, 1920, 5, 239–314, 14 pls.). Probably about 1824 *Lantana aculeata* was introduced into India; it is one of the Verbenaceæ from the Tropical American Region; it has become a pest in regions that suit it, displacing the native vegetation. In Hawaii it has been to some extent checked by the introduction of an Agromyzid, but it is not certain that this insect would be equally beneficial in India. In Hawaii there is an almost complete absence of any plant closely allied to *Lantana*, but this is not the case in India. The introduction of insects to feed on weeds is a very dangerous experiment. The author's investigations have brought to light a long list of insects that attack *Lantana* in India and Burma. The most efficient of these is *Platyptilia pusillidactyla*, a small Plume-moth whose larva feeds on the flower-heads and reduces the output of seeds to a considerable extent. Attacked flower-heads produce only a few sickly berries instead of a number of healthy ones. The insect is widely distributed already in India, Burma, and Ceylon, and would be even more efficient than it is were not its numbers considerably reduced by Hymenopterous parasites. But no insect is likely to be more than a check. Cutting and burning are also needed.

J. A. T.

**Effect of Light on CO<sub>2</sub>-output in Certain Orthoptera.**—JOSEPH HALL BODINE (*Journ. Exper. Zool.*, 1922, 35, 47–55, 3 figs.). It has been shown by Loeb and others that the primary effect of light consists in changes in the tension or tonus of muscles. Bodine's experiments with various kinds of grasshoppers show that the action of light on the eyes, affecting the tonus of muscles, is associated with a decrease in the rate of the CO<sub>2</sub>-output of the organism. A similar decrease in the rate of CO<sub>2</sub>-output is also found in decapitated individuals.

J. A. T.

**Chemical Sensitivity of Red Admiral's Tarsi.**—DWIGHT E. MINNICH (*Journ. Exper. Zool.*, 1922, 35, 57–81, 3 figs.). In *Pyrameis atalanta* each of the four ambulatory tarsi possesses numerous chemoreceptors. The appropriate stimulation of these receptors produces a response in the form of an extension of the proboscis. The manifestation of this response varies somewhat, depending upon the chemical nature of the stimulus and the nutritional condition of the individual. A study of these differences of response shows that this butterfly can distinguish through its tarsal organs distilled water, 1M saccharose, and 2M common salt. It is also able to distinguish M/10 quinine hydrochloride from distilled water, from 2M common salt, and probably from 1M saccharose. The efficiency of distilled water in evoking the proboscis response is directly dependent upon the nutritional condition of the animal, but this is not the case with the other substances. Since the organs of the tarsi are contact chemoreceptors, and since they are concerned with the discrimination of substances to be taken as food, they may be approximately termed organs of taste.

J. A. T.

**Tracheal Ramifications in *Dytiscus*.**—ALEXIS KÖPPEN (*Zool. Anzeig.*, 1921, 52, 132-9, 4 figs.). Some precise details of the extraordinarily fine ramification of the tracheæ, e.g. on the gizzard and the crop of this water-beetle. There is what may be called a capillary network. The state of affairs in the fat-body is also described, and a striking figure is given of the inter-penetrating branching on the stomatogastric nerve. Anastomoses were only seen in a few cases in the spiral tracheæ of the hind-gut. There are no anastomoses among the capillary ramifications.

J. A. T.

**Olfactory Organs of Wasps and Bees.**—R. VOGEL (*Zool. Anzeig.*, 1921, 53, 20-28, 4 figs.). A description of sensory cones (sensilla basiconica), sensory plates (sensilla placodea), and sensory hairs (sensilla trichodea olfactoria) in wasps and bees. Each type includes a group of very small sensory cells with distal processes. These cells vary in number in the three types, respectively, 30-40, 12-18, 5-10; they are innervated by very delicate nerve-fibres; the distal processes always contain near their outer ends a row of characteristic granules. The queen-bee has about 2,000 olfactory plates on each antenna, the worker about 6,000, and the drone about 30,000; and each placode has about 16 sensory cells. The drones are obviously well equipped for finding a queen. Cones and hairs occur on the antennæ of Myriopods; the cones may be derived from the hairs by increase in the chitinous portion and in the number of sensory cells. By shortening of the cones plates may arise.

J. A. T.

**Nymph of *Gryllus campestris* with Three Cerci.**—J. REGEN (*Zool. Anzeig.*, 1921, 52, 189-90, 1 fig.). Among about 2,000 larvæ of this cricket there was a nymph with three cerci—two being asymmetrically disposed on the right side of the ovipositor, one on the left side. The specimen died at the last moult, and two others which showed a hint of a third cercus also failed to reach the imago stage.

J. A. T.

#### δ. Arachnida.

**Reproduction and Sex in *Ornithodoros moubata*.**—N. CUNLIFFE (*Parasitology*, 1921, 13, 327-47, 1 pl., 5 figs.). Copulation may occur between individuals of two species, *O. moubata* and *O. savignyi*, and the stimulus of coition may induce oviposition. But the eggs are non-fertile. There is no evidence of parthenogenesis in *O. moubata*. There is no ecdysis after reaching maturity. An increase in temperature from 8° C. to 22° C. doubles the rate of oviposition, decreases the fertility of the eggs by 30 p.c., reduces the longevity of the female tick from 715 to 397 days, i.e. by 40 p.c.; and apparently halves the period required for metamorphosis, under laboratory conditions. At 37° C., under laboratory conditions, reproduction is inhibited, and the longevity of the female is reduced by 80 p.c. An individual may undergo from four to eight ecdyses before reaching maturity. The great majority of the males appear after the fifth ecdysis, and the females about equally after the fifth and sixth ecdyses. Engorgement may take place one or two days after emergence, at any stage, the average time required being

three-quarters of an hour. Moisture has an adverse influence on the vitality of the individual, excess of moisture inhibiting growth. The external characters which serve to differentiate the sexes are discussed in a note by G. H. F. Nuttall. The only essential difference is in the structures surrounding the genital orifice.

J. A. T.

"Lyriform Organs" of Spiders.—HANS VOGEL (*Zool. Anzeig.*, 1921, 53, 177–81, 3 figs.). A study of the "cleft organs" and "lyriform organs" in *Aranea sclopetaria*. Each "cleft organ" shows a chitinous, a hypodermal, and a nervous portion. The latter consists of sensory cells, each of which is proximally connected with the nervous system and continued distally in a terminal process to a minute cleft in the integument. They occur singly and in "lyriform" groups. In the spider in question there are about 4,000 "clefts" and 132 "lyriform" groups. The latter occur only at the joints of the appendages. The single clefts occur on the joints, or diffusely, or on the abdomen where muscles are inserted. As to the function of these structures there is no certainty. They probably function as touch organs and as receptors for differences in pressure at the joints.

J. A. T.

New Linguatulid from a Batrachian.—L. GEDOELST (*Records Indian Museum*, 1921, 22, 25–6). Description of a small Linguatulid, *Raillietiella indica* sp. n., from the lung of a toad (*Bufo melanosticha*). This is the first case of a Linguatulid in a Batrachian.

J. A. T.

#### 6. Crustacea.

Abnormal Antennæ in Amphipods.—CHAS. CHILTON (*Ann. Mag. Nat. Hist.*, 1921, 8, 116–8, 2 figs.). In a specimen *Orchestia chiliensis* the second antennæ showed two extra joints in the peduncle, five being the normal number. In a specimen of *Hyale brevipes* from Chilka Lake there was on the penultimate joint of the peduncle of the second antenna a small appendage nearly as long as the joint from which it arises. It was only on one antenna, and may have been the result of some injury.

J. A. T.

Amphipods from Juan Fernandez.—CHAS. CHILTON (*Nat. Hist. Juan Fernandez and Easter Island*, 1921, 3, 81–92, 4 figs.). A small collection of five species and a new variety of one of them. There is a special interest in *Orchestia chiliensis*, which has long been known from Chile and from New Zealand. It is a seashore form in New Zealand, but in Juan Fernandez it occurs up to 500 m. above sea level, and in one case it shows characters which make its general appearance similar to that of the purely terrestrial species of *Talorchestia*. In other cases no modification appears to have taken place.

J. A. T.

*Asellus aquaticus*.—CHAS. CHILTON (*Ann. Mag. Nat. Hist.*, 1920, 5, 200–3). The author calls attention to Racovitza's evidence that *Asellus aquaticus* includes another quite distinct species, *A. meridianus*. On examining his British specimens, Chilton found that both species were represented, and a statement is given of the more important differences between the two.

J. A. T.

**Development of External Features of *Branchipus grubei*.—**ALFRED OEHMICHEN (*Zool. Anzeig.*, 1921, **53**, 241-53, 18 figs.). The first five stages are described, with particular reference to the antennæ, the mouth-parts, and the limbs. J. A. T.

**Symbiosis of Isopods and Hydroids.**—E. STECHOW (*Zool. Anzeig.*, 1921, **53**, 221-3, 1 fig.). Symbiosis between *Brachynura* and Hydroids has been recorded in many cases, but it is rare between Isopods and Hydroids. Stechow reports the luxuriant growth of *Obelia geniculata* on the posterior half of *Anilocera physodes* in the Mediterranean, and the occurrence of *Obelia longa* sp. n. on the posterior dorsal surface of *Serolis zoiphila* from Kerguelen. There does not seem to be any masking of the Isopod, as the growth is confined to the posterior regions. The Hydroids may profit by being carried about and by getting particles from the Crustacean's repasts. J. A. T.

**Fresh-water Crab in Tasmania.**—CHAS. CHILTON (*Proc. Roy. Soc. Tasmania*, 1919, 93-5). The small crab *Hymenosoma lacustris* Chilton was originally described from near Auckland, New Zealand, and has since been recorded from other localities in New Zealand, also from Norfolk Island, Lord Howe Island, and from two localities in Victoria. Its occurrence, now reported, in Tasmania is additional evidence of its wide distribution and of its antiquity. There are some peculiarities in the Tasmanian specimens, but not marked or constant enough to justify their separation. J. A. T.

**Blood-cells of *Astacus*.**—R. NOLD (*Zool. Anzeig.*, 1921, **52**, 277-85, 7 figs.). The blood of *Astacus fluviatilis* includes amœbocytes and trophocytes—both colourless. The former are in a great majority. Most of the trophocytes migrate into the tissues. In Molluscs the trophocytes are restricted to the tissues. The amœbocytes show active movements, with pointed hyaline pseudopodia which sometimes form anastomoses. It seems probable that a spherical shape is assumed when the amœbocytes are not in small arteries and capillaries with a slowed flow of the blood. The minute structure of the amœbocytes is described. A nucleus may occasionally show a median constriction, but it does not seem likely that division ordinarily occurs in the blood. The trophocytes are derivable from young amœbocytes. The protoplasm increases, mitochondrial secretion granules appear around the nucleus, and in the vicinity of the granules there arise nutritive trophoplasts which break up and make the protoplasm very vacuolate as they disappear. The trophocytes retain the phagocytic capacity of the amœbocytes. J. A. T.

**Development of *Panulirus japonicus*.**—ARATO TERAQ (*Rep. Imp. Fisheries Inst. Tokio*, 1919, **14**, 1-7, 4 pls.). The egg-fixing cement seems to be due to the tegumental glands of the swimmerets of the female. The cells from the blastopore migrate *en masse* into the yolk, becoming a dome-shaped syncytium. In the intermediate areas between the appendages of the egg-nauplius there are lateral or inter-appendicular growth-stripes. There are three unpaired dorsal organs, which may be interpreted as embryonic moulting-glands. The longitudinal contraction

of the body at the egg-nauplius stage leads to the ultimate separation of the embryonic exuviae. There is an anterior budding zone between the labrum and the thoraco-abdominal fold. It gives rise to the two pairs of maxillae, whereas the posterior budding zone gives rise to the maxillipedes and walking-legs. The second maxillae have a marked inward direction of growth—a recurrence of an ancestral character. Coelom sacs are found, in most cases indistinctly, at the bases of the appendages. They are larger posteriorly. The yolk cells are first formed from the blastoderm; they have nothing to do with mesoderm; they never turn into blood cells or connective tissue cells; they act on the food-yolk as the mid-gut does, and may be grouped under the endoderm.

J. A. T.

**Surprising Appearance of a Cyclops Species.**—RUDOLF NEUBAUR (*Zool. Anzeig.*, 1921, 52, 161). Report of the abundant occurrence of *Cyclops distinctus*, regarded by Schmeil and others as a hybrid between *C. fuscus* and *C. albidus*. It was a rarity to Schmeil, who found only three females. But about 1912 Neubaur found this large and strikingly coloured species in abundance near Halle, and in the ten years that have elapsed since then he has found it plentifully in many places (e.g. Plön, Holstein, Berlin). It could not have been overlooked before, and it must have had an extraordinary prosperity since Schmeil's monograph of about a quarter of a century ago.

J. A. T.

**Transition Forms between Species of Copilia.**—CARL LEHNHOFER (*Zool. Anzeig.*, 1921, 52, 232–8, 7 figs.). Discussion of transitions between the males of *Copilia quadrata* Dana and *C. lata* Giesbr., especially as regards the antennae. The intergrades suggest continuous variability rather than hybridization.

J. A. T.

#### Annulata.

**Metabolic Gradient in Annelids.**—LIBBIE H. HYMAN and ALBERT E. GALICHER (*Journ. Exper. Zool.*, 1921, 34, 1–16, 3 figs.). By means of the susceptibility and electrical methods, evidence has been accumulated which clearly indicates the existence of a double metabolic gradient in the Oligochaet and Polychaet Annelids. According to this evidence, the anterior and posterior ends possess the highest metabolic rate, and from these ends the rate decreases towards the middle regions. In the majority of forms the posterior end has a higher metabolic rate than the anterior end. The paper includes direct determinations of the rate of oxygen consumption per unit weight of pieces from anterior, middle, and posterior regions of the Oligochaet *Lumbriculus inconstans* and also from the Polychaets *Nereis virens* and *N. vexillosa*. The results of these determinations are that the posterior pieces of these species consume the most oxygen per unit weight per unit time, the anterior pieces less, and the middle pieces least. The results, therefore, confirm the conclusions drawn from other methods and establish beyond reasonable doubt the existence of a metabolic gradient in these forms.

J. A. T.

**New Type of Nephridia Found in Indian Earthworms of the Genus Pheretima.**—KARM NARAYAN BAHL (*Quart. Journ. Micros. Sci.*,

1919, 64, 67-119, Plates 6, 7, 8, and 3 text-figs.). Nephridia are not "plectonephric," as hitherto described for this genus. A large number of extremely fine tubules can be observed, and these are situated mostly on the septa and the inner surface of the body-wall. Altogether there are three different sets, named according to their position, the *septal*, the *integumentary*, and the *pharyngeal*. The septal nephridia are attached on both sides of all the septa behind the fourteenth segment. They do not open on the external surface of the earthworm, but communicate, through a pair of septal excretory canals situated on each septum, with a pair of supra-intestinal excretory ducts running longitudinally near the mid-dorsal line below the dorsal blood-vessel. These longitudinal excretory ducts communicate segmentally with the lumen of the gut, through which the excretory products due to the activity of the nephridia would seem to be passed out. The number of septal nephridia in each coelomic chamber is from 80 to 100. The integumentary nephridia are less than half the size of the septal, but very much more numerous, and are attached to the inside of the body-wall. They open directly to the exterior by numerous nephridiopores. The pharyngeal nephridia occur in tufts and surround the oesophagus in the fourth, fifth and sixth segments. These open by long muscular ducts into the pharynx and buccal cavity of the worm. Since the essential feature of this new type of nephridia is that all the numerous septal and pharyngeal nephridia are connected with a system of ducts, which open not on the surface of the skin, but into the intestine and other regions of the gut, the term "enteronephric" is proposed to distinguish it. The nephridia have been exhaustively investigated in *Pheretima posthuma*, and in addition to the general plan, the arrangement of the ducts, the histology of these organs is also dealt with, and comparison made with the nephridial system of some other species of *Pheretima*.

B. L. B.

#### Nematohelminthes.

**Nematodes from the Camel in India.**—C. L. BOULENGER (*Parasitology*, 1921, 13, 311-4, 3 figs.). Descriptions of *Hæmonchus longistipes* Railliet and Henry and *Nematodirus mauretanicus* Maupas and Seurat.

J. A. T.

**Strongylids from Punjab Horses.**—C. L. BOULENGER (*Parasitology*, 1921, 13, 315-26, 5 figs.). Notes on twenty-one species, not including any new forms, with fresh information on the structure and development of some of the less familiar, as well as remarks on geographical distribution. The majority of the species of horse sclerostomes seem to have a very wide distribution, many forms being now known from five continents.

J. A. T.

**Vinegar Eels.**—ARNOLD ZIMMERMANN (*Revue Suisse Zool.*, 1921, 28, 357-79). Success has attended Zimmermann's endeavours to find a perfectly aseptic culture for *Anguillula*, and he has demonstrated the possibility of continued life and reproduction in these conditions. This has been already proved for the fruit-fly *Drosophila*. But the continued reproduction is only possible if there be added to the simple nutritive

media, such as peptone-lecithin, a substance soluble in water and in weak alcohols—an extract of yeast which differs from vitamins in its resistance to even repeated sterilization.

J. A. T.

**Oesophageal Fibres of Some Nematodes.**—CARL ALLGEN (*Zool. Anzeig.*, 1921, 53, 76–84). In the oesophageal wall of Nematodes there are two systems of fibres which have received various interpretations. The angle-fibres (Kantenfasern) have been regarded by some as muscular, by others as connective or elastic. Allgen finds in his study of *Odentogeton* g. n. (from the wart-hog) definite proof that they are muscular. The main or radial fibres are indubitably muscular. In other cases the same holds true; the two sets of fibres are both muscular and aid in the passage of food through the gullet.

J. A. T.

#### Platyhelminthes.

**New Cestode from Pouched Rat.**—F. J. MEGGITT (*Parasitology*, 1921, 13, 193–204, 1 pl.). The duodenum of *Cricketomys gambianum* contains specimens of a Cestode with unarmed scolex and no persistent uterus, *Inermicapsifer zanzibarensis* sp. n. The author contrasts it with the other species, and discusses the unsatisfactory distinctions between *Inermicapsifer* v. Janicki, *Zschokkeella* Fuhrmann, and *Thysanotænia* Beddard.

J. A. T.

**Protolepsia tessellata.**—EMILE ANDRÉ (*Revue Suisse Zool.*, 1921, 28, 443–7, 1 pl.). Record of a specimen of this leech from the Lake of Geneva. It is new to Switzerland and is rare everywhere. It has been reported from Chile as well as from various European countries. It has probably been brought to Switzerland by some aquatic bird. It is very transparent, and eleven pairs of cæca were seen shining through.

J. A. T.

**Triple Pharynx in Polycelis.**—AUGUST THIENEMANN (*Zool. Anzeig.*, 1921, 53, 118–9, 1 fig.). A teratological case of triple pharynx in the Planarian *Polycelis cornuta* from Holstein. There had probably been a transverse post-pharyngeal fission, and in regeneration a new pharynx had developed on each side of the original pharynx. There was a functional lumen in each. The Holstein forms multiply only asexually. There is normally a multiplication of the pharynx (polypharyngism) in some North American species of *Planaria* and in some Triclad.

J. A. T.

**Excretory System of a Cercaria.**—ERNEST CARROLL FAUST (*Parasitology*, 1921, 13, 205–12, 6 figs.). An account of the structure and development of the excretory system in a cystocercous larva (*Cercaria pekinensis* sp. n.) from the testis of *Vivipara lapillorum*. The system consists of a bladder, a drainage canal through the tail, and a pair of anterior collecting tubules, each of which receives eight main (tertiary) branches. Each branch is composed of  $2 \times 4 \times 4$  units. The branch situated most posteriorly has to do with the drainage of the tail. A study of representative stages in development shows that the common denominator of the excretory system is  $\alpha + \beta$ , while the pattern of the developed cercaria is expressed by  $4(\alpha)^2 + 4(\beta)^2$ . The fundamental

pattern of the cercaria is likewise found in the sporocyst. The data have a bearing on the application of mathematics to the problems of growth and development. There is a fundamental pattern potentially inherent in the protoplasm.

J. A. T.

#### Cœlentera.

**Polarity in Obelia.**—E. J. LUND (*Journ. Exper. Zool.*, 1921, **34**, 471–93, 3 pls., 3 figs.). A study of the effects of electric currents on regenerating internodes of *Obelia commissuralis*. Cut-off internodes possess and retain an inherent polarity, according to which the regeneration of a hydranth occurs at the apical end before that at the basal end. Apical internodes develop hydranths earlier than internodes of basal origin. With an appropriate density of electric current all hydranth formation on ends of internodes when turned towards the cathode can be delayed or entirely inhibited, while at the same time hydranths may form in a high percentage of pieces on ends pointed toward the anode. In the same conditions stolons may regenerate and function normally on ends toward the cathode. These two statements hold for pieces irrespectively of whether the basal or the apical end of an internode is pointed toward the anode. That is, the inherent normal polarity of the internode may be reversed by means of an electric current. A current density barely able to inhibit regeneration in basal internodes cannot inhibit regeneration in apical internodes of the same branch. The establishment of an electrochemical polarity is probably a primary, fundamentally associated condition for the development of morphological polarity, for it has been shown that the physiological mechanism which determines morphological polarity can be controlled and directed by an electric current of external origin.

J. A. T.

**Plumularidæ of Hirondelle and Princess Alice.**—MAURICE BEDOT (*Résultats Campagnes Scientifiques de Monaco*, 1921, **60**, 1–72, 6 pls.). An account of new species of *Polyplumaria*, *Halicornaria*, and *Cladocarpus*, and fresh information about many other Plumularids. He also discusses a number of genera, much multiplied of recent years, in the sub-family Eleutheropleinæ, e.g. *Thecocaulus* and *Schizotrichia*.

J. A. T.

**Green Hydra fusca.**—W. GOETSCH (*Zool. Anzeig.*, 1921, **53**, 173–6). Report of a stock of brown Hydra which exhibited a temporary infection with green algæ. The infected forms belonged to Schulze's proposed genus *Pelmatohydra*, and it may be said that symbiosis does not occur in this group. But the genus "*Hydra*," which remains after separating off the stalked *Pelmatohydra* and *Hydra viridis* (now called *Chlorohydra*), may show in a culture a lasting symbiosis with algæ, and Goetsch also reports on this. The infection with *Chlorella* sp. may be effected with the aid of Daphnids. A constant expulsion of algæ was observed. The symbiosis observed was not seen in natural conditions; it occurred in laboratory aquaria.

J. A. T.

**Revision of Genus Plexaura.**—JOHANNES MOSER (*Zool. Anzeig.*, 1921, **53**, 110–18). A useful revision of this Alcyonarian genus, which is restricted to the littoral region of the Tropical West Atlantic. A

good diagnosis is given. Then follows an appalling list of forty-six species referred to *Plexaura* erroneously, and another of thirty-seven which should be included in the genus but have been otherwise named. Nineteen secure species are recognized, and a diagnostic key is given. Then follow descriptions of four new species.

J. A. T.

**Scyphomedusan Jelly-fishes from the Philippines.**—S. F. LIGHT (*Philippine Journ. Sci.*, 1921, 18, 25-46, 4 figs.). Thirty-nine species and varieties of Scyphomedusæ are known from Philippine waters—a surprisingly large number. The present paper describes two new genera and one new species. One of the new genera is *Anomalorhiza*, a dichotomous Rhizostome, differing strikingly from other genera in the unusual branching of the mouth arms, which are dichotomously branched only near the tip, the entire outer surface of the arm being quite bare; in the presence of a very large, distinct ring canal; in that the interocular canals are but eight in number; and in the absence of any externally visible musculature. The other new genus is *Cotylorhizoides*, also a dichotomous Rhizostome, with eight simple bifurcated mouth arms, the terminal branches pinnate. There are no radial muscles. The strong circular muscles are interrupted in the eight principal radii. The circular canal is small or absent. The bell is high and dome-shaped, without a central dome-shaped region as in *Cotylorhiza*. The two new genera emphasize, what Mayer has pointed out, that the group *Rhizostomata dichotoma* is not sharply defined from *Rhizostomata triptera*.

J. A. T.

**Classification of Actiniaria.**—T. A. STEPHENSON (*Quart. Journ. Micr. Sci.*, 1920, 64, 425-574, 1 pl., 32 figs.). In this very important revision of the sea-anemones the author seeks to show that the exact form of the pedal disc, the presence or absence of capitular ridges, the thickness of the body-wall, and the form of the tentacles apart from actual structural differentiation of parts of them, are characters which it would be profitable to discard as sole generic distinctions; that the distribution of the gonads is not invariably a reliable generic character; and that presence or absence of definite verrucæ and acrorhagi, and of a cuticle in some cases, the presence or absence of basal swellings or other tentacular specializations, the limitation of the cycles of tentacles to two only (at the same time as the mesenteries are normally arranged in several cycles) in some forms, the form of the retractor muscles in most cases, the position of the longitudinal tentacular musculature (whether ectodermal or mesoglæal), and the presence or absence of the mesoglæal sphincter, are more valuable characters which may usually be emphasized in distinguishing genera.

J. A. T.

**Symbiosis of Siphonophora and Zooxanthellæ.**—M. KUSKOP (*Zool. Anzeig.*, 1921, 52, 257-66, 7 figs.). A discussion of the symbiotic Zooxanthellæ in *Velella spirans* and *Porpita umbella*. In *Velella* they occur especially in the so-called hepatic canals, the sail, the endoderm cells of the margin, and in the medusoids. The larvæ are infected very early, probably through the mouth. In *Porpita* the symbions are very abundant in the hepatic canals. In both types they may crowd out into the mesenchyme. There is, however, a general suggestion of a regulated partnership, not of a random infection.

J. A. T.

## Protozoa.

**New Type of Parasitic Protist in Fly Larvæ.**—D. KEILIN (*Parasitology*, 1921, 13, 97–113, 3 pls., 5 figs.). In the general cavity, fat-body and nervous system of the larva of a fly, *Dasyhelea obscura*, which lives in the decomposed sap filling the wounds of trees—elm and horse-chestnut—Keilin found *Helicosporidium parasiticum* g. et sp. n. It differs from all the actually known Protists, and forms a new type which may be temporarily included among Sporozoa. The trophic stage has the form of a small round cell, 2–3  $\mu$  in diameter, with a minute spherical nucleus. There is very active schizogonic multiplication. Schizonts form a small morula of 4  $\mu$  in diameter, composed of four or eight merozoites, which become free. The spore, 5–6  $\mu$  in diameter, is composed of four cells surrounded by a thin wall or sporocyst. Of the four cells, three, which are the real sporozoites, are discoidal and occupy the centre of the spore. The fourth cell forms a peripheral spiral filament surrounding the three central cells. The spores open inside the dead body of their host by the unrolling of the spiral filament, and the sporozoites are thus liberated. The spiral filament when unrolled is 60–65  $\mu$  long, pointed at both ends, 1  $\mu$  thick at its widest portion, and very resistant. Its nucleus is 2–3  $\mu$  long and lies 15  $\mu$  from one end of the filament. The strange parasite occurs also in a Dipteron (*Mycetobia pallipes*) and a mite (*Hericia hericia*), both of which occur in tree wounds. J. A. T.

**Human Coccidiosis.**—FRANK G. HAUGHWOUT (*Philippine Journ. of Science*, 1921, 18, 449–82, 4 pls., 1 fig.). Description of a case of infection with *Isospora hominis*. An account is given of the sporoblast formation, the sporozoites, the development of the cysts, and so on. The parasite enters the alimentary tract in encysted form. There are two tetrazoic spores, there being eight sporozoites formed in each case. In the intestine the vermiform sporozoites emerge from their containing cysts and invade the epithelial cells of the mucosa of the small intestine. They are obligatory epithelial-cell parasites. Within the host cell the sporozoites develop into trophozoites, which grow at the expense of the protoplasm of the cell. When the food supply is exhausted and the trophozoite has attained full growth, the nucleus undergoes multiple division (schizogony) and with plastogamy a number of daughter cells, or merozoites, are formed. These escape from the host cell and enter the lumen of the intestine to seek new host cells. Those that are successful develop in their turn into trophozoites which also undergo schizogony. This asexual cycle is repeated a variable number of times, and finally changes take place leading to a sexual process (sporogony), which is initiated by a process of fertilization involving the union of sexually differentiated gametes. This is followed by the encystation of the zygote, which then passes out with the faeces and completes its development in the outer world. In the course of time the whole race undergoes sporogony and the host is clear. J. A. T.

## BOTANY.

(Under the direction of A. B. RENDLE, M.A., D.Sc., F.R.S., F.L.S.)

## GENERAL,

Including the Anatomy and Physiology of Seed Plants.

## Cytology,

Including Cell-Contents.

**Cytological Study of a few Compositæ.**—MASATO TAHARA (*Journ. Coll. Sc. Tokyo*, 1921, **43**, 1-53, 4 pls., 13 figs.). An account of the cytology of species of *Chrysanthemum* and *Erigeron*. Although many species of *Chrysanthemum* exhibit 18 or 9 chromosomes during cell-division (and these numbers are regarded as being characteristic of the genus), several species show a variation in the number of haploid

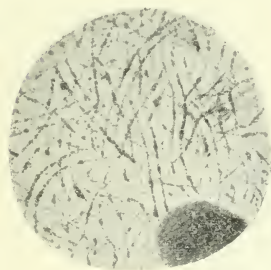


FIG. 1.



FIG. 2.

FIGS. 1-5.—REDUCTION-DIVISION IN POLLEN-MOTHER-CELL OF *Chrysanthemum coronarium*..

Fig. 1, Formation of parallel threads; Fig. 2, Synapsis stage; Fig. 3, Spireme stage; Fig. 4, Contraction stage; Fig. 5, Early diakinesis.

chromosomes: thus *C. indicum* and *C. Leucanthemum* have 18, *C. hakusanense* and *C. morifolium* 21, *C. Decaisneanum* 36, and *C. marginatum* and *C. arcticum* 45.

In a few species the seeds have numerous embryo-sac-mother-cells, but the reduction-division is normal. *C. coronarium* was found most suitable for the study of reduction-division of the pollen-mother-cells. The threads are parallel during early prophase; the true longitudinal

splitting begins in later synapsis, reaches its maximum with loop-formation, and then becomes less distinct, until in diakinesis it is scarcely visible. In the early stages the chromosomes are united end to end to form a continuous thread. In the second synapsis the thread folds together, assumes a spiral form and then segments into separate

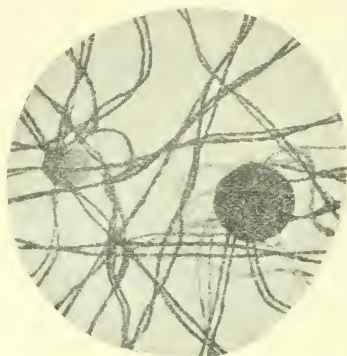


FIG. 3.



FIG. 4.

pairs of chromosomes. *C. coronarium* thus exhibits an intermediate type of reduction-division which should reconcile the "folding" and "splitting" theories.

*Chrysanthemum* exhibits an unusual type of wall-formation in the tetrad-division of the pollen-mother-cells. The cell-wall has four



FIG. 5.

ingrowths which gradually grow inwards and meet together, dividing the cell into four daughter-cells. "Shasta-Daisy" is a bastard resulting from the crossing of a Japanese species of *Chrysanthemum* with another species—probably *C. arcticum*. Its nuclear-division is peculiar and indistinct; in the heterotypic stage 85 chromosomes are visible, but their subsequent behaviour shows that 40 of these are monovalent and

45 bivalent. The numerous garden species of Japanese chrysanthemums are found to have the same number of chromosomes as *C. morifolium*, a fact which appears to indicate that the latter is the parent of all these species. *Erigeron annuus* is parthenogenetic, but *E. linifolius* and *E. dubius* are normally sexual. In the first species the pollen-grains are of unequal size, and each contains a single nucleus. In somatic nuclear division 26 chromosomes are present; the first division of the embryo-sac-mother-cell is not heterotypic, and the four nuclei share equally in the formation of the embryo-sac, which thus has also 26 chromosomes. Nuclear division in the endosperm shows 52 chromosomes.

In *E. linifolius* embryo-sac development is normal, but the antipodals are anomalous; the two cells give rise, by repeated nuclear and cell-division, to a row of antipodal cells, each containing one, two, or more nuclei. *E. dubius* has only 9 chromosomes and has an unusual embryo-sac development. The first two cell-divisions are normal, but no cell-walls are formed, and the four megaspores all share in the formation of the embryo-sac, which ultimately contains 16 or more nuclei. S. G.

**Gross Structure of Agar Gel.**—C. L. CAREY (*Bull. Torr. Bot. Club*, 48, 173–82, 4 figs.). A study of the gross structure of agar gels, which shows that the lamellated appearance is probably due to rapidity of drying and varies with the temperature used. When dried at a temperature of 21°–25° C. no such structure is seen, although one or two slits appeared. The structure is unaffected by stretching on silk, since it was also obtained when pieces were suspended or dried on trays in the oven. The finest structures were obtained with 5 p.c. gels; those of lower concentrations dried at 43° C. and 70° C. showed no great differences. Drying takes place from the outside inward, and therefore the gel has a higher water-concentration inside than outside, so that the percentage weight of water and agar at the beginning of the structure-formation cannot be given accurately. S. G.

### Structure and Development.

#### Vegetative.

**Interruption of Endodermis in *Dracæna*.**—A. G. MANN (*Proc. Roy. Soc. Edin.*, 1920–1, 41, 50–59, 11 figs., 2 photos). A study of

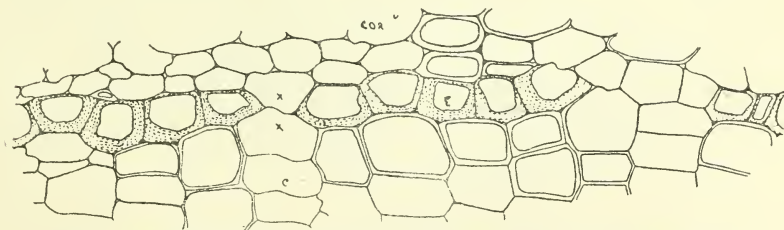


FIG. 1.—Steps in the breaking up and displacement of endodermis, *e*, by intrusion of parenchyma cells at *x*.  $\times 250$ .

the secondary thickening in the root of *Dracæna fruticosa*, with special reference to the discontinuity of the endodermis. A series of sections

of one root showed that disturbance of the regularity of the endodermis was due to cambium cells which developed from the cells of the pericycle within the endodermis. Active development of this internal cambium

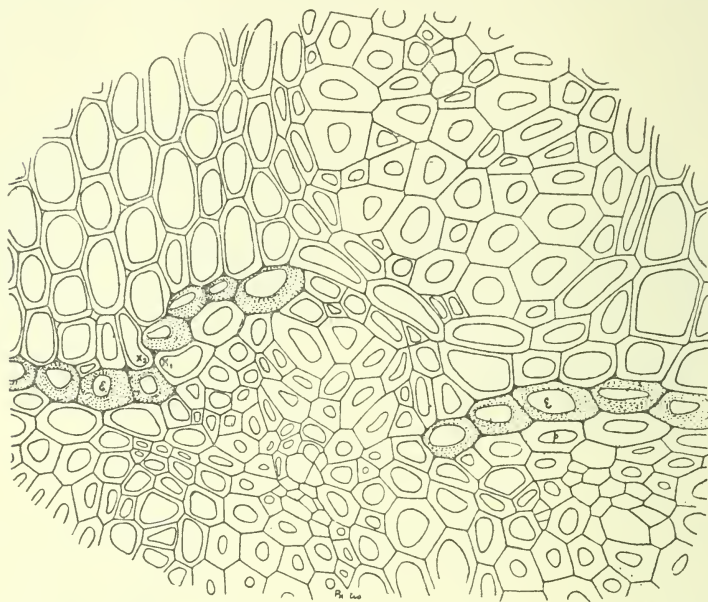


FIG. 2.—Endodermis curved and continuity broken by pressure of tissues within. Cells  $x_1$   $x_2$  show the beginning of separation of endodermal cells.  $\times 250$ .

caused a bending and displacement of the endodermal ring, owing to an intrusion of the newly formed parenchymatous cells. Cambial activity

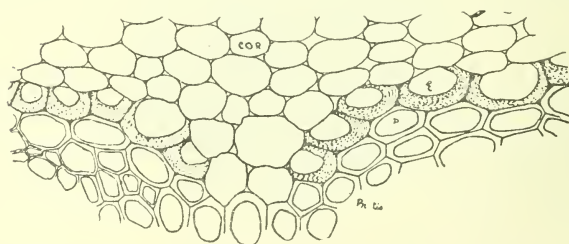


FIG. 3.—Separation of endodermis by intrusion of cortex, cor.  $\times 250$ .

then ceased, and the endodermis once more became continuous, but fresh cambiums appeared again at intervals and more parenchymatous cells were intruded among the endodermal cells. At the same time

isolated patches of cambium appeared in the outer cortex and caused still further breaking up of the endodermis. Ultimately the rudiments of two secondary bundles appeared in the cortex, and subsequent sections showed a rapid development of secondary tissue all round the root from both internal and external cambium; the endodermis was now almost completely broken up into patches of isolated cells. In a second root of a more woody nature the secondary cambium first appeared in the outer cortex and gave rise to several isolated bundles; secondary cambium was then formed in different parts of the pericycle, and, extending outwards, broke through the endodermis to meet the outer secondary cambium. Ultimately the two sets of cambium united and formed a typical continuous cambium, giving rise to secondary bundles and conjunctive tissue. The interruption of the endodermis appears to be "an adaptation to allow of a greater increase in girth of the root for the formation of new vascular tissues, and for a quicker interchange between the outer and inner tissues of the enlarging root. S. G.

**Vessels in Seed-plants.**—M. C. BLISS (*Bot. Gaz.*, 1921, 71, 314–26, 5 pls.). M. C. Bliss has investigated the origin of the vessel in *Pteris*, in the Gnetales and in the Dicotyledons, and finds that while in *Pteris* the primitive vessel is scalariform, in the Gnetales it is pitted. In *Pteris* the scalariform perforation of the end wall often becomes pitted, but in *Gnetum scandens* the more or less regular fusion of pits results in a scalariform perforation. In the typical *Gnetum* vessel, however, haphazard fusion of the pits gives rise to a porous perforation. Similar haphazard fusion of pits occurs in *Pæonia*, *Cydonia* and *Leea*, while in *Liriodendron*, *Magnolia*, *Betula*, *Alnus*, *Quercus*, *Vitis* and some species of *Pæonia*, the fusion may be serial and result in scalariform perforations. The evolution of the perforations of the vessels in the Gnetales and Dicotyledons appears to be similar, resulting in both cases from pit-fusions. Examination of primitive parts of *Liriodendron*, *Magnolia*, *Pæonia* and *Vitis* shows that the primitive vessel of Angiosperms is pitted and has been derived from the pitted tracheid. S. G.

#### Reproductive.

**Pollination of Incarvillea.**—E. M. CUTTING (*Ann. Bot.*, 1921, 35, 63–71, 3 figs.). *Incarvillea Delavayi* has a large sensitive stigma, and anthers with stiff prongs for opening the anther-lobes and setting free the pollen. Each anther has two such prongs, which are so arranged that one lobe must open and liberate its contents when the insect enters the flower, and the other lobe when the insect passes out. The pollen-grains resemble those of *Thunbergia alata* as described by Goebel, but differ slightly in the slits of the exine; in the latter species these slits form one or two continuous lines, but in *Incarvillea* they only join occasionally. The pollen-grains are dry, and are able to germinate in quite low temperatures in the open air, but fail to do so under artificial conditions, even at high temperatures. The closing of the slits when the grains are dry and the high osmotic pressure of their contents may be regarded as adaptations to prevent excessive loss of water during transmission of the pollen. S. G.

## Physiology.

**Food-reserve in Cotyledons.**—B. M. DUGGAR (*Ann. Missouri. Botan. Gard.*, 1920, 7, 291–98, 1 pl., 2 figs., 2 tabs.). The author has studied the nutritive value of the food-reserve in cotyledons and in endosperm. In the first experiment twenty-four pairs of seedlings of field-peas were grown in culture-solution, and the cotyledons of one of each pair of seedlings were removed on each day for twenty-four days. For a period of seven days this removal caused a marked but diminishing depression in the rate of growth of the seedling as compared with that of the control. Further experiments, somewhat modified, show that the cotyledons are practically exhausted in ten days; removal after that period produced little effect upon growth. The removal of the scutella and endosperm from corn-seedlings produced similar, but far less marked, results. In subsequent experiments attempts were made to substitute organic nitrogenous nutrients, such as glycocoll, alanin, sodium asparaginate and sodium nucleinate, for the loss of the cotyledons, but with unsuccessful results. The failure appears to be due to (1) need for a combination of amino acids, or (2) the difficulty and slowness of penetration of organic substances, or (3) the absence of a vitamine that may be found in the cotyledons. All plants like beans and peas which have fleshy cotyledons show a similar depression of growth when these cotyledons are removed, and the influence of this depression is perceptible throughout the entire period of growth of the plant. S. G.

**Synthesis of Carbohydrates in Plants.**—E. BALY, I. HEILBRON and W. BARKER (*Journ. Chem. Soc.*, 1921, 119–20, 1025–35). A study of the synthesis of formaldehyde and carbohydrates from carbon dioxide and water. It is now proved that an aqueous solution of  $\text{CO}_2$  gives formaldehyde when exposed to light of very short wave-length ( $\lambda = 200\mu\mu$ ). When the solution is further exposed to light of wave-length  $290\mu\mu$ , the formaldehyde is polymerized to reducing sugars. This photosynthesis can be induced in ordinary white light by the use of malachite-green, methyl-orange and other coloured basic substances as catalysts. Under certain conditions of screened lighting an equilibrium is set up between the relative amounts of sugar, formaldehyde and  $\text{CO}_2$ , but in unscreened light the equilibrium lies far over to the side of the  $\text{CO}_2$ ; in the presence of a photocatalyst, capable of functioning in both stages of the reaction, the equilibrium is shifted entirely over to the side of the reducing sugar. Chlorophyll appears to be an ideal photocatalyst of this description, and thus the formation of carbohydrates in the growing leaf without the free existence of formaldehyde is explained. S. G.

## General.

**Inbreeding and Crossbreeding in Crepis.**—J. L. COLLINS (*Univ. Californ. Pub. Agric. Sc. II.*, 6, 1920, 205–16, 3 pls.). The results of inbreeding and crossbreeding in *Crepis capillaris* show that the conditions induced by inbreeding this naturally cross-fertilized plant strongly resemble those produced by inbreeding of maize. The third and fourth generations exhibit the maximum reduction. The  $F_1$  generation of plants produced by crossing inbred strains with non-inbred

strains is vigorous and of rapid growth. Inbred plants develop more slowly than crossbred plants throughout the entire period of growth, and sometimes have sterile pollen. Vigour and development are unaffected by improved conditions of growth. The present work confirms the results obtained by East and Jones with maize, and show that the immediate results of inbreeding naturally cross-fertilized species are injurious; this appears to be true in all cases where similar conditions affect sexual reproduction. S. G.

**Interspecific Hybrids in *Crepis*.**—E. B. BABCOCK and J. L. COLLINS (*Tom. cit.*, 194–204, 2 pls.) have studied hybrids of *Crepis capillaris* and *C. tectorum* with special reference to the chromosome theory of heredity. These species were selected as suitable for investigation because of the small number of their chromosomes, *C. capillaris* having three pairs and *C. tectorum* four pairs. It was found that reciprocal crosses were equivalent. The  $F_1$  generation showed dominance of the *tectorum* characters of the cotyledon, and the greater vigour of growth, as exhibited in greater size of the parts of the seedling. No plant survived the cotyledon stage, owing to the absence of organization and co-ordination of the functioning systems. It has been suggested that species of a large number of chromosomes may have originated from species with a smaller number, owing to fragmentation or segmentation of the latter. The results of the present work show that *C. tectorum* cannot be related in this way to *C. capillaris*. S. G.

**Chemical Method of Distinguishing Genetic Types of *Rudbeckia*.**—ALBERT F. BLAKESLEE (*Zeitsch. Abstamm. u. Vererbungslehre*, Berlin, 1921, 25, 211–21, 1 pl.). An account of an attempt to resolve phenotypes into genetic groups by means of chemical reagents. Observations have shown that while the cones of *Rudbeckia hirta* usually have purple cones, two genetic types have yellow cones. In appearance the two types are indistinguishable, but they are found to give different colour changes when the cones are treated with various chemicals. In one type, known as the Black Yellow, the cones turn black when treated with a caustic alkali, while in the other type, which is known as the Red Yellow, the cones turn red when treated with these alkalis. Both the Black Yellow and the Red Yellow characters are inherited as simple Mendelian recessives. When crossed the  $F_1$  generation consists of purple-coned individuals. In the  $F_2$  generation purples are to yellows in the ratio 9 : 7. The results show that genes for Black Yellow and Red Yellow are in different chromosomes. Further experiments in the same direction appear to be desirable. S. G.

## CRYPTOGAMS.

### Pteridophyta.

**Structure in Palæozoic Bituminous Coals.**—REINHARDT THIESSEN (*Department of the Interior, Bureau of Mines, Bulletin 117, Washington, Government Printing Office, 1920, 296 pp., 160 pls.*). This richly illustrated report contains chapters on the work of previous investigators,

the methods of preparing samples for examination, the origin of peat, structure in coal, microscopic examination of coal, the microscopic components in detail—namely, humic matter, resinous matter, spore exines, rodlets (some of which are traced to the mucilage canals of the Medullosæ), fungi—and, finally, a comparison of the structures of the coals.

A. GEPP.

**Branching of the Zygopteridean Leaf and its Relation to the Probable "Pinna" Nature of *Gyropteris sinuosa* Goeppert.**—B. SAHNI (*Annals of Botany*, 1918, **32**, 369–79, 3 figs.; see also *Bot. Centralbl.*, 1919, **140**, 165). The author's view of the branching of the Zygopteridean leaf is opposed to those put forward by P. Bertrand and by Kidston and Gwynne-Vaughan. In all Zygopterideæ there are but two rows of pinnæ (secondary rachis), one on each side of the leaf. The supposed secondary rachis of *Stauropteris*, *Metaclepsydropsis*, *Diplolabis*, *Dineuron* and *Elopteris* are really tertiary (pinnules), and the result of the forking of the true secondary rachis. The latter are completely fused to the primary rachis, but their strands are distinct. It is probable that *Gyropteris sinuosa* is a secondary rachis of a form like *Metaclepsydropsis* or *Diplolabis* with an acquired cortical sheath independent of the primary rachis. The mode of branching of the *Stauropteris* leaf conforms to the rectangular system. The laminated portions of the Zygopterid leaf were probably expanded more or less horizontally, with all the segments in the same place. *Clepsydropsis* Unger (1856) is extended so as to include *Ankyropteris* P. Bertrand (1909), but contains two sections named after the two original genera respectively. The Zygopterideæ are divided into two sub-families, Clepsydroidæ and Dineuroideæ, on the basis of the vascular structure. And a table is given which shows the relations of the genera with a modification of P. Bertrand's latest scheme.

A. G.

***Polypodium vulgare* as an Epiphyte.**—DUNCAN S. JOHNSON (*Bot. Gaz.*, 1921, **72**, 237–44, figs.). A number of examples of this species growing as an epiphyte high up on the north side of unbranched trunks of *Quercus* *Prinus* near Baltimore, in Maryland. Apart from their smaller size they apparently differed in no way from terrestrial examples. The author discusses the food of epiphytes, and the origin of temperate zone epiphytes—a tropical origin according to Schimper; and claims that *Polypodium vulgare* is an endemic epiphyte of the temperate zone, a facultative epiphyte, a hardy plant with thick-enticled fronds capable of rolling up in dry weather and so checking transpiration.

A. G.

**Vegetative Reproduction and Aposporous Growths from the Young Sporophyte of *Polypodium irioides*.**—W. N. STEIL (*Bull. Torrey Bot. Club*, 1921, **48**, 203–5, figs.). An account of the sporophytic and gametophytic outgrowths obtained from young sporophytes which had developed from prothallia cultivated on nutrient solution under laboratory conditions.

A. G.

**Some Remarks on Native Ferns.**—G. VON BECK (*Oesterreich. bot. Zeitschr.*, 1918, **67**, 52–63, 113–123; see also *Bot. Centralbl.*, 1919, **140**, 184). This paper brings together a quantity of morphological

details (chiefly concerning sporangia, spores, indusium, etc.), discussion of nomenclature, descriptions of new forms, and addition of new localities. New forms are described for *Botrychium lunaria*, *Asplenium fissum*, *Phegopteris dryopteris* and *Nephrodium montanum*. The tribe Pterideæ, containing the genera *Gymnogramme*, *Notholaena*, *Allosaurus*, *Adiantum*, *Cheilanthes*, *Pteris* and *Pteridium*, deserves to be maintained as a proper tribe in the family Polypodiaceæ, by reason of its globular tetrahedral spores with 3-rayed "keimspalte"; the tribe Polypodiæ (represented in Austria by *Polypodium* only) is more closely allied by its reniform spores with linear "keimspalte" to the other tribes Asplenieæ and Aspidieæ. *Phyllitis* is to be maintained as a genus-name. Heufler's sub-species *nigrum*, *serpentinii*, and *onopteris* of *Asplenium adiantum-nigrum* are, at the most, varieties. If *Phegopteris*, *Aspidium*, *Nephrodium*, *Dryopteris*, *Lastrea*, etc., be placed in one genus, it must bear the name *Polystichum* Roth. As regards the mid-European flora, the author divides *Nephrodium* Rich into two sections: (1) *Lophodium* Newm., with four species and two hybrids: and (2) *Hemistheum* Newm., with two species. Four forms are recognized for *Nephrodium spinulosum* and *N. Villarsii* respectively. *Cystopteris filix fragilis* is divided into forms and sub-forms according to division and form of sporophyll pinnæ and pinnules. A scheme for the classification of several forms of *Cystopteris* is suggested. *Cystopteris regia* Desv. has obtuse lobes at the apex of the pinnæ and pinnules (it is a high Alpine race of *C. filix fragilis*). *C. sudetica* A. Br. is a good species. The most southerly station for *Onoclea struthiopteris* in the Eastern Alps is the Isonzothal. In *Woodsia* each upper cell of the articulated hairs of the indusium is to a certain extent set in the lower one.

E. S. GEPP.

### Bryophyta.

**Centrosomes in Fertilization Stages of *Preissia quadrata* (Scop.)**  
 Nees.—M. GRAHAM (*Annals of Botany*, 1918, 32, pp. 415–20). Centrosomes are present in the nuclear division figures of many algae and fungi, but are absent in the higher plants. There is very little evidence as to whether they are present during the stages of fertilization in plants, though in animals it is fairly well established that, in many cases at least, the centre which has been brought into the egg by the sperm divides in the formation of the cleavage spindle. In the Bryophytes and Pteridophytes, in a number of cases, the centre which becomes the blepharoplast is described as arising by division from a centre which has appeared at the poles of the karyokinetic figure in the last preceding division, or in several of the preceding nuclear divisions. No one has however followed the centre through the processes of fertilization in these groups. The author's investigations show that in *Preissia quadrata* centrosomes as definite granular bodies are present not only in the divisions just preceding spermatogenesis, and, as blepharoplasts, during metamorphosis, but also in the fertilized egg at the time when the pronuclei are paired. Further observations are promised as to the behaviour of the centres during the earlier stages of the fusion of the antherozoid with the egg.

A. GEPP.

**Chromosomes of *Conocephalum conicum*.**—AMOS M. SHOWALTER (*Bot. Gaz.*, 1921, **72**, 245-9, 2 pls.). A study of sex potentialities in chromosomes. It has been claimed that two spores out of every tetrad in *Sphærocarpos* and *Thallocarpus* produce male plants, and the other two yield female plants. In several dioecious mosses also the sex potentialities are probably separated during the reduction divisions. As yet a visible chromosome difference between the sexes has been found only in two plants, both of them species of *Sphærocarpos*. The results are negative in *Conocephalum*; but the author finds: (1) The chromosome number in the gametophyte is *nine* instead of eight as reported by previous investigators. (2) The chromosomes vary considerably in size, one being very much smaller than any of the other eight. (3) There is no perceptible difference between the chromosomes of the male and those of the female plant. (4) The plants received from Ithaca and Copenhagen show the same number and size relations of the chromosomes as do the Wisconsin plants. A. G.

**The Liverworts of Somerset.**—W. WATSON (*Somersetshire Archaeological and Nat. Hist. Soc.*, 1920, **66**, pt. 2, 134-59, figs.). A list of 102 species of Hepaticæ and numerous varieties and forms, with some notes interspersed. The distribution within the county of Somerset is given, together with the authority for each record. A comparison is made with the neighbouring counties of Devon and Gloucestershire. A. G.

#### Thallophyta.

##### Algæ.

**Physiological Researches on Green Algæ grown in pure Cultures.**—H. KUFFERATH (*Bull. Soc. Roy. Bot. Belg.*, 1921, **54**, 49-77, 78-102). In Part I. the author discusses shortly the action of strongly concentrated gelatine on species of Bacteria, and then gives the results of his experiments with the same medium on algæ, varying the concentration between 15 and 70 p.c. Morphological details of each culture are given, according to the various percentages of concentration. Certain species will grow in any concentration, but development is better and more abundant in the less strong ones. Species of *Hormidium*, *Stichococcus lacustris* Chod., *Chlamydomonas intermedia* Chod., and *Chlorococcum viscosum* Chod. hardly grow at all in concentrations exceeding 25 p.c. or 30 p.c. It is found that in all species except *Stichococcus* a proportionate increase of cell-dimensions takes place, corresponding with the increase in concentration of gelatine. A reduction of growth takes place, in proportion to the lack of water in the gelatine, except in the case of algæ whose natural habitat is more or less dry. Sporulation, which is normal and active in weak concentrations, ceases in strong ones. Reduction of cell-division takes place. In Part II. the author describes his researches into the action of various osmotic substances on *Chlorella luteo-viridis* and *Hormidium lubricum*. Finally, in his conclusions, he sums up the results in general. As regards the action of osmotic inorganic salts, the author confirms previous researches in so far that in the case of a combination of osmotic salts each salt acts independently,

and the limit of development is produced by the salt which exercises the strongest osmotic power. The results obtained show that with a combination of salts the reactions are not so simple as might be imagined at first. Details are given of the experiments carried out and the methods employed.

E. S. GEPP.

**Serological Studies with Unicellular Algæ.**—R. LIESKE (*Sitzber. Heidelberg Akad. Wiss.* 1916, B. 3, 48 pp., 4 figs. in text; see also *Bot. Centralbl.*, 1919, **140**, p. 135). The cultivation of fifteen species of unicellular algæ on six different media, organic and inorganic, is described, absolute purity being indispensable. The animals into which these were injected were rabbit and frog. Methods and results are fully set forth. The author finds that the colourless mutations of the algæ react serologically in the same way as the corresponding green cultures grown purely heterotrophically. The serological difference between green and colourless cultures is not caused by the presence or absence of chlorophyll, but by the autotrophic or heterotrophic method of nutrition conditional thereon. From the systematic standpoint it is noted that a close albumen relationship exists between *Chlorella vulgaris* and *Stichococcus bacillaris*. The latter belongs, therefore, not to Ulotrichales but to Scenedesmaceæ.

E. S. G.

**Coloration of Fresh-water by Plant Life.**—E. NAUMANN (*Bot. Notiser*, 1919, 225–339; see also *Hedwigia*, *Beiblatt*, 1921, **62**, p. (88). A continuation. (viii) A coloration caused by *Scenedesmus quadricauda* was observed throughout the entire waters of the "Great Restaurant Pond" in the Berlin Zoological Gardens. (ix) A new case of coloration by *Trachelomonas volvocina* var. *subglobosa* occurred in a pond, Plydammen near Ljunghy, on very poor heathland, in which the fish had been plentifully fed with meal. The author concludes that the easily oxidised iron compounds arising from the mud strata represent a *sine qua non* for the development of the *Trachelomonas*. (x) *Scenedesmus quadricauda* forms a constituent of the coloured mass-production of summer plankton in "Baltic" lakes. The Falkenhagen lake in Brandenburg, not far from Berlin, is cited as having been coloured green by this alga in the summer of 1915. It was accompanied by numerous colonies of *Microcystis*, which may perhaps have added to the effect. (xi) A feeble coloration by *Dinobryon cylindricum* was observed in July 1915 in the Iguanodon pond in the Berlin Zoological Garden.

E. S. G.

**Cytological Studies in the Protococcales. III. Cell Structure and Autospore Formation in *Tetrædron minimum* (A. Br.) Hansg.**—GILBERT MORGAN SMITH (*Annals of Botany*, 1918, **32**, 459–64, 1 pl.). Little is known concerning the cytological structure of members of *Tetrædron*. The author's investigations show that young cells of *T. minimum* contain a single nucleus and pyrenoid. Repeated simultaneous karyokineses may produce as many as eight nuclei within a single cell. Autospores are formed by progressive cleavage, the number of nuclei increasing during the process. Four, eight, sixteen or thirty-two uninucleate protoplasts are the final product of this cleavage,

these protoplasts being metamorphosed over into autospores. The pyrenoid disappears after the first cleavage, new pyrenoids being formed *de novo* in the young autospores. A. GEPP.

Addition to our Knowledge of Oscillatoriaceæ.—A. C. J. VAN GOOR (*Rec. trav. bot. Néerland.*, 1918, 15, 255–9, 1 pl.; see also *Nuova Notarisia*, 1921, 32, 168). Descriptions are given of four new species of *Oscillatoria* and one of *Lyngbya*, collected in lakes and ditches, etc., in various parts of Holland. E. S. G.

On the Fossil Algæ of the Petroleum-yielding Shales of the Green River Formation of Colorado and Utah.—C. A. DAVIS (*Proc. Nat. Acad. Sci. Washington D.C.*, 1916, 2, 114–19; see also *Bot. Centralbl.*, 1919, 140, 164). The region in question consists of large areas of, generally, carbonaceous shales, exceeding in places 3000 ft. in thickness, and yielding petroleum. The ground mass seems to have been originally vegetable matter, and contains a large percentage of low algæ. Three distinct types have been discovered:—(1) A very considerable number of cellular, filamentous, and gelatinous forms clearly belonging to Cyanophyceæ. One of these can almost certainly be referred to *Spirulina*. (2) Somewhat less common forms belong more or less certainly to Chlorophyceæ. One resembles *Pediastrum* in all essentials; another type has been noted with spiral chloroplasts, like *Spirogyra*. (3) Unclassified algæ, which cannot at present be placed with any known living species. E. S. G.

Cell-membrane and Cell-division of *Closterium* Nitzsch. Critical Remarks.—J. LÜTKEMÜLLER (*Ber. Deutsch. Bot. Gesell.*, 1917, 35, 311–18; see also *Bot. Centralbl.*, 1919, 140, 138). A challenge to statements of van Wisselingh. That author denied segmentation of the cell-wall of *Closterium*; and maintained that the older part of a cell which had undergone division must possess more layers of cell-wall than the younger part, since a new layer must be added at each division. An examination of *C. turgidum* Ehrb. subsp. *giganteum* Nordst. shows segmentation; and the number of layers in the cell-wall was always the same in both halves. On the other hand, it is true that several of the layers are the richer in cellulose the nearer they lie towards the centre of the cell. The author shows by means of figures that in species of *Closterium* with growth subsequent to cell-division the number of sutures is *even* where there is one median girdle, and *uneven* where there are two; which proves the correctness of the statement that typical periodical subsequent-growth takes place in girdled *Closterium* species. Irregular girdle formation was found in about 3·5 per 1000 cases, a proportion which is negligible. It occurs in *C. didymotocum* Corda, *C. Baileyanum* Bréb., and *C. costatum* Corda, which are otherwise vegetatively normal, and in which zygospores are unknown. If many such cases occurred in *Closterium*, van Wisselingh would be correct in regarding the presence or absence of girdle formation as having no systematic value. E. S. G.

Characteristics of some Coscinodiscineæ.—A. C. J. VAN GOOR (*Rec. travaux bot. Néerland.*, 1920, 17, 1–25, figs.; see also *Nuova*

*Notarisia*, 1921, **32**, p. 165). Notes on the structure of the valves and on auxosporogenesis in certain diatoms of the following genera :—*Thalassiosira*, *Coscinodiscus*, *Cyclotella*, *Stephanodiscus*. A. G.

**Micro-organisms of Bicarbonated and Saline Waters in Galicia.**—

B. NAMYSŁOWSKI (*Bull. Intern. Acad. Sci. Cracovie*, math.-nat. Sér. B., 1914, 526–544, 2 pl.; see also *Bot. Centralbl.*, 1919, **140**, 183). In the bicarbonated waters ferro-bacteria appear in considerable quantity, also *Navicula mesolepta*. Other species regularly occurring are—*Achnanthes lanceolata*, *A. microcephala*, *Cymbella amphicephala*, *C. cymbiformis*, *Stauroneis anceps* and *Van Heurckia vulgaris*. Other diatom species are found, but more rarely. New teratologic forms of *Navicula mesolepta* and *Stauroneis anceps* are recorded. In the superficial saline springs sixty species are recorded, some of them characteristic of such habitat, others flourishing equally well in saline or fresh water. *Achnanthes brevipes* shows an anomaly; and certain individuals of *Navicula interrupta* from the “Solec” spring differ from the diagnosis in De Toni’s “*Sylloge Algarum*.” Together with flagellates and bacteria and one fungus (*Oospora salina*), the number of micro-organisms recorded from seven subterranean saline waters is seventy-nine. E. S. G.

**Algal Flora of the Komotau-Udwitz Ponds.**—J. GREGER (*Lotos*, Prag., 1914, **62**, 115–23). The group of ponds embraced by this title consists of the Alaun- or Hütten-see near Komotau, and four ponds by Udwitz, in Bohemia, forming a superficial area of about 40 hect. The Udwitz ponds are well known as resting-places for migrant birds, and also as nesting-places; and being seldom disturbed, they offer a good situation for the development of algæ, etc. The flora of the Alaun-see was very meagre, and consisted principally of Diatoms, owing to the presence of 1 p.c. of alum in the water. The number of species recorded for the four Udwitz ponds is 208, and that for the Alaun-see is but 21. New to the flora of Bohemia are: Schizophyceæ, 9; Chlorophyceæ, 13; Conjugatæ, 23; Diatomaceæ, 27. E. S. G.

**Algal Flora of the Komotau-Udwitz Pond-group. II.**—J. GREGER (*Beih. z. Bot. Centralbl.*, 1920, **37**, 299–309; see also *Hedwigia*, *Beiblatt*, 1921, **62** (85)). A continuation of the work begun in 1913, and published in *Lotos*, 1914, p. 115. The phytoplankton of the Alaun-see shows a noticeable increase since 1913—a sign that the alum content is constantly decreasing. Diatoms remain much the same as regards number of species; Cyanophyceæ and Chlorophyceæ show additions. Desmids still remain entirely absent. The migration of the filamentous algæ from the banks towards the middle of the lake, to avoid the action of rain-water, has increased. It is clear that the colonization of the Alaun-see by plankton is proceeding. Diatoms still predominate and are evenly distributed. It is fairly certain that the majority of the species are introductions, and some of them will hardly survive. E. S. G.

**Algæ of Moravia and their Distribution.**—R. FISCHER (*Verh. naturf. Vereins in Brünn*, 1920, **57**, 94 pp., 1 pl., 2 figs. in text; see

also *Hedwigia*, *Beiblatt*, 1921, 62, 85). A first contribution, omitting the Flagellates and the Volvocales. After a short introduction the author gives a general discussion on the distribution of the algae in the area investigated. He found that they are not scattered arbitrarily over the country, but follow a certain rule which is intimately connected both with the geognostic substratum and the chemical constituents of the water. Other important factors are the orographic and climatic conditions. Three geographical areas are recognized: 1. The tertiary and quarternary country south of Brünn. 2. The hilly palaeozoic country north and north-east of Brünn. 3. The archaic region of western Moravia belonging to the Bohemian-Moravian plateau, embracing the districts of Neustadt, Gross-Meseritsch, and Iglau. These three areas are described orographically and chemically, and the species and varieties characteristic of each are given. Two new species are described, *Tetradron robustum* and *Lauterborniella major*. Critical remarks and measurements are appended to many of the records, which number 455 species. E. S. G.

Materials for the Algological Flora of the Bulgarian Coast of the Black Sea.—S. PETKOV (*Revue Acad. Bulgare Sci.*, 1919, 17, 25-134, tab. and fig.; see also *Nuova Notarisia*, 1921, 32, 164). A list of 16 Diatomaceae, 3 Desmideae, 5 Chlorophyceae and a *Polysiphonia*, collected in brackish and fresh waters along the Bulgarian coast of the Black Sea from Douran-Koulak to Achthopolis. A. G.

Charophyta of the Lower Headon Beds of Hordle Cliffs (South Hampshire).—C. REID and J. GROVES (*Quart. Journ. Geol. Soc.*, 1921, 77, 175-92, 3 pls.). The first part of this paper deals with the geological beds in which the *Charophyta* are found. The second part contains descriptions of the *Charophyta* remains. They consist of numerous detached fruits, some fragments of stems and branchlets, and a few stem-nodes with portions of the internodes of stems and the bases of the branchlets attached. There were also a few bodies which are apparently the actual stem-nodes. In no instance was a fruit found attached to a branchlet, and, owing to the fact that in each deposit more than one type of fruit was present, it was not possible to identify any of the fruits with the vegetative parts to which they belong. The fruits, which are described, would appear to consist only of those which have developed a "lime-shell," similar to that with which we are familiar in many existing species of *Chara* and in a few *Tolypella*. The presence of the lime-shell has ensured their preservation. The oospore was found in a few cases only. The fruits are very diverse in shape and size, some of them resembling those of living species. Twelve species of *Chara* and *Tolypella* are identified, of which ten are new. Under "Vegetative Remains" the authors deal with the stems and branchlets, a large proportion of which appear to belong to a single type. The stems consist of numerous short fragments, ranging in diameter from about  $250\mu$  to  $400\mu$ . The branchlets of these are fairly numerous, but are also extremely fragmentary, varying in thickness from about  $170\mu$  to  $250\mu$ . Both stems and branchlets of the principal type are described in detail, and short descriptions are given of the fragments of four other types

less well-represented. Further material examined after the death of the former of the two authors showed several more or less complete stem-nodes with small portions of the internodes and branches attached. Two types are represented, the first resembling *Chara canescens* among living species. The second type resembles *Chara imperfecta*, except that the fossil species has fairly large stipulodes, while in the living species these are rudimentary.

E. S. G.

**Marine Algæ of Denmark. Contributions to their Natural History. Part II. Rhodophyceæ: II. (Cryptonemiales).—L. K. ROSENVINGE** (*K. Dansk. Vidensk. Selsk. Skrift.*, vii. Ser., tom. 7, 2, 155–283, 2 pls. and 128 figs.). An important contribution to our knowledge of many species of Cryptonemiales. The forty species recorded belong to Dumontiaceæ, Nemastomataceæ, Rhizophyllidaceæ, Squamariaceæ, Hildenbrandiaceæ, Corallinaceæ and Gloiosiphoniaceæ. The structure of the thallus and the structure and development of the reproductive organs are described and figured for most of the species; also their distribution in Danish waters. Two new species of Squamariaceæ are described and the sexual organs of four known species. The family Hildenbrandiaceæ is here restored, characterized by the absence of lime, by immersed sporangia, and by oblique divisions of the sporangia. The development of the immersed sporangia is described. In Corallinaceæ the fusion of cells, by means of pores in the transverse and vertical walls, is discussed, a process which may be followed by fusion of nuclei. Hyaline hairs occur in *Melobesia*, *Lithophyllum* and *Corallina*; the cells producing them are called by the author “trichocytes” and are the heterocysts of Rosanoff. The structure and development of the sporangia of *C. officinalis* are described, as also the antheridia of *Lithothamnion Lenormandi*. In *Lithophyllum Corallinæ* the isolated spermatia found in the conceptacle contained two nuclei; a number hitherto observed only in spermatia when fixed to the trichogyne and not earlier. An aberrant position of carpospores was noticed in certain species. Five new species of *Melobesia* are described. This genus can be distinguished from *Dermatolithon*, a subgenus of *Lithophyllum*, by the absence of transverse pores between the upright cell-series proceeding from the basal layer in *Melobesia*, and their presence in all species of *Lithophyllum*. The germination and development of the antheridia is described in *Gloiosiphonia capillaris*. The paper closes with some general remarks on Cryptonemiales. Intercalary cell-division has been observed in *Dumontia incrassata* and *Hildenbrandia prototypus*; and cell-fusion in Squamariaceæ. Alternation of generations and alternation of nuclear phases are discussed. Observations made on *Furcellaria fastigiata* and *Petrocelis Kennedyi* point to a possibility of parthenogenesis. In *Petrocelis Kennedyi* and *Cruoria pellita* tetraspores and sexual organs have been met with in the same individual. In all these cases it must be presumed that the tetrasporangia are formed without reduction of chromosomes. Finally, the author opposes Svedelius’ suggestion that cruciate tetrasporangia are possibly always produced without reduction of chromosomes.

E. S. G.

**Additions to the Study of Oceanic Algology (Florideæ).—**ANGELO MAZZA (*Nuova Notarisia*, 1921, **32**, 73–132). The structure of typical species of the following genera is described:—*Hypnea* (4 species); *Faucheia* (4 and a variety); *Gloioderma* (1); *Rhodymenia*, *Epyrmenia* (1); *Erythrymenia* (1); *Sebdenia* (1); *Lomentaria*, *Plocanium* (3 sub-genera—*Plocanium*, *Thamnocarpus*, *Thamnophora*—and 4 species); *Halosaccion* (1). The systematic position of the genus *Erythrymenia* Schmitz has still to be decided; the name is not to be found in De Toni's "Sylloge Algarum," nor in the "Pflanzenfamilien" of Engler. It represents a South African alga, *E. obovata* Schmitz, found by Dr. H. Becker at the Kowie, and named by Prof. Schmitz just before his death. It appears to belong to the Rhodymeniaceæ. A. G.

**Monospores of Helminthora divaricata, with a Note on the Binuclear Carpogonium.**—N. SVEDELIUS (*Ber. Deutsch. Bot. Gesell.*, 1917, **35**, 212–24; see also *Bot. Centralbl.*, 1919, **140**, 163). The material examined was collected at Rovigno. The species is monœcious and lacks the tetraspores. Monospores rich in protoplasm are formed at the termination of the filament, often associated with a hair. It would almost appear sometimes as if two sporangia were formed successively, but so far this remains unproved. The monospores resemble carpospores, and they possess amœboid movement. On germination a creeping filament is formed; the spore itself remains empty and undivided, and does not pass into the tissue. The carpogonium is, at the very least during a short phase of development, binuclear, in contrast to other observations previously made on this species. The entrance of the second nucleus into the trichogyne could not however be demonstrated. E. S. G.

**Biological Observations on Polysiphonia fastigiata Grev.**—C. SAUVAGEAU (*Rec. trav. bot. néerland.*, 1921, **18**, 213–30). After a short survey of past work on this alga, the author describes his own investigations of material growing on *Ascophyllum nodosum*, *Fucus vesiculosus* and *F. platycarpus*. Germination, which proceeds similarly in both carpospores and tetraspores, is described and figured both under natural conditions and under artificial culture. The alga is shown to be parasitic and not epiphytic; its rhizoids take on the character of endophytic suckers. Although *P. fastigiata* is provided with chromatophores, it certainly derives part of its sustenance from its host, as is proved by the production of adventitious branches exclusively in the immediate neighbourhood of the suckers. The limitation of its occurrence—namely, on *Ascophyllum* and *Fucus* only—is explained by the adaptation of the plant to a parasitic life. It occurs less frequently on *Fucus* than on *Ascophyllum*, although its rhizoids penetrate the cuticle of both without difficulty; it also grows less luxuriantly on the former host. These facts would indicate a less satisfactory nutrition from *Fucus*. The sucker is directed on the host by chemiotropism, not by negative phototropism. Notwithstanding its constant parasitism in nature, its spores germinate easily in cultures, on glass slides, and produce plantlets.

E. S. G.

**Position of the Chromatophores in the Palisade Cells of Marine Florideæ and Green Foliage.**—G. SENN (*Verhandl. Naturforsch. Gesellsch. Basel*, 1916, 23, 104–22, figs. ; see also *Bot. Centralbl.*, 1919, 140, 242). In the palisade cells of *Peyssonnelia Squamaria* and *Platoma cyclocolpa*, the chromatophores in diffuse illumination of moderate intensity are ranged in antistrophe on the transverse walls towards the source of light. By illumination of the under side of the thallus of *Peyssonnelia*, the chromatophores are obliged to collect together in the lower ends of the cells, which then are the best lighted. Apostrophe is brought about in the cells of *Platoma* through prolonged deficiency of light, parastrophe through intensive illumination. The difference between the position of the chromatophores in the palisade-cells of marine algæ (antistrophe) and of green leaves (epistrophe) in optimum diffused illumination is caused by the difference of the optical conditions. Under certain treatment antistrophe can be brought about in foliage also. The occurrence of palisade parenchyma in marine algæ does not appear to be an adaptation to diffuse illumination, as in green foliage, but it is caused by the special growth conditions of the thallus.

E. S. G.

**On the Gelose of Certain Florideæ.**—CAMILLE SAUVAGEAUX (*Bulletin de la Station biologique d'Arcachon*, 1921, 18<sup>e</sup> année, 113 pp.) Some Red Algæ when boiled in water yield a carbohydrate which jellifies upon cooling. These algæ are discussed, and the preparation and characters of the jellies are described. These are of three types:—1. In *Gelidium* and some eight other genera the decoction, even when very dilute, sets into a jelly upon being cooled. Some of their cell-walls can be stained by a solution of iodine, owing to the presence of a substance comparable with amyloid. 2. In *Chondrus* and seven or more genera the decoction sets in a mass if well concentrated, or, if diluted, it sets under the action of certain electrolytes. The walls do not stain with iodine. 3. In *Polyides* and four other genera the jellification is intermediate between the other two types; aluminium sulphate has a particularly coagulating action upon it: the cell-walls are permeable to carbohydrate, and in general are insensitive to iodine.

European species of *Gelidium* are as valuable as those used by the Japanese for making "kanten" (agar), but are more scarce. If Japanese agar were pure its jellifying properties would be still more accentuated. The bleaching of algæ in the open air, as done in Brittany and Ireland, often damages the material. Artificial bleaching is not much employed. When boiled sufficiently, the mucilage of *Chondrus* is nearly colourless, whether the plants have been bleached in the open air or not: the colour of material which has been artificially bleached by sulphurous acid or by sodium bisulphite is generally darker; and "phycocolle," which is darker-coloured than mucilage, becomes quite decolorized in a solution of potassium chloride without losing its properties.

Many of the particularities in the chemical or histo-chemical nature of the cell-membrane have yet to be studied. The cellulose of *Gelidium* and *Gracilaria* (the only genera examined by the author) resists the action of cupro-ammonia. In the pectic or cellulosic parts of certain

*Floridææ* occurs an *amyloid* substance which is stained by iodine to a violet, more or less brownish, or more or less reddish, indicating variations in its constitution. Sometimes it is restricted, sometimes diffused through all the cell-membranes, except the cuticle. Its general presence in the *Gelidium* group suggests that it plays a part in the jellyfication of this group; yet it occurs in *Halopithys* and *Laurencia* which yield no gelose; and also at the rhizoidiferous base of *Porphyra*, though its cell-walls differ chemically from those of other red algæ in containing no cellulose. By further micro-chemical research it is found that there is an amyloid of the nature of starch, and a second one of the nature of the dextrines. A. G.

**Corallinacæ of the Tripoli Coast.**—R. RAINERI (*Nuova Notarisia*, 1921, **32**, 133–49). The material of this work was collected by Prof. Parona in 1912–13 during the Italian Scientific Expedition to the Libyan coasts. The Corallinacæ form a living embankment or reef in course of formation. The species recorded belong to *Lithothamnium*, *Lithophyllum* and *Melobesia*, and are discussed individually, the structure being described and figured. Two species of *Corallina* and *Peyssonnelia rubra* Grev. are also recorded from the protected rocky coast. E. S. G.

**Fossil Corallinacæ of Libya.**—R. RAINERI (*Atti Soc. Ital. Sci. Nat.*, 1920, **59**, 137–48, 7 figs.; see also *Nuova Notarisia*, 1921, **32**, 167). A report on material collected by Prof. Parona. Four new species are described, including *Arthrocardia cretacea* and *Amphiroa Mattiroliana*. These genera have not previously been recorded from Cretaceous strata. *Archæolithothamnium Paronai* and *Lithothamnium lybicum* are also new to science. Other known species are discussed. E. S. G.

**Dwarf Generation in Pogotrichum and the Reproduction of Laminaria.**—P. KUCKUCK (*Ber. Deutsch. Bot. Gesell.*, 1917, **35**, 557–58; see also *Bot. Centralbl.*, 1919, **140**, 151). The first part of this paper is devoted to a consideration of “prospory” in *Pogotrichum filiforme* Rke., a phenomenon already described by the author, but not taken up in current literature. On the basal disc, from which later the upright thallus is developed, plurilocular sporangia are formed, and on the upright thallus are unilocular ones. The two phases occur in seasonal succession, the dorsiventral basal-disc thallus predominating in spring, and later on the upright radial thallus. This should be of interest in studying the development of alternation of generations. Germination of the spores of the upright thallus produced very reduced plantlets, which consisted sometimes only of one vegetative cell and a plurilocular sporangium. The author considers it not impossible that these forms may also occur in nature. In the second part of the paper the author discusses the work of Sauvageau on the dwarf sexual generation of *Saccorhiza bulbosa*, and describes a similar phenomenon in *Laminaria saccharina*. Minute prothallia are developed, bearing oogonia and antheridia. Spermatozoids and the process of fertilization have not yet however been observed. The female thalli can produce more than one oogonium; the male thalli bear antheridia in close

clusters. The author considers Sauvageau's suggestion of dividing off Laminariaceæ to form an entirely separate group is justified, but as yet somewhat premature. As regards the germination of the zoospores of *L. saccharina* the extending germ-tube forms a globular swelling at its end, which then proceeds to divide up, whereby the spore and the adjoining portion of the tube are left empty. Apparently a few-celled protonema is then formed.

E. S. G.

**Gametophytes and Fertilization in Laminaria and Chorda.** (Preliminary Account).—J. LLOYD WILLIAMS (*Annals of Botany*, 1921, 35, pp. 603-7). In the study of artificial cultures of germinating spores of Laminariaceæ the presence of a much smaller brown alga is always observed; the terminal cells of its branches are often found to be empty; and the question arose whether these could be the antheridia of the male gametophyte. In the mixture of organisms of the culture it is exceedingly difficult to prove such a point; yet the author had the great luck actually to observe the liberation of the antherozoids, and to secure stained preparations showing the fusion of the sexual nuclei, and even to witness the process of fertilization. He gives a preliminary outline of the course of events in the development of the gametophytes and the process of fertilization of *Chorda* and *Laminaria*. The male gametophyte is much smaller than the female, and divides up into much smaller and more numerous cells. The apical cell becomes paler, and, after the modification of its cell-wall, bursts and liberates the single antherozoid; gradually the other cells escape in like fashion. The formation of the oogonium and the thickening and subsequent rupture of the oogonial wall are described; the solitary egg was observed to be fertilized after emergence. Preparations were obtained showing the gametic nuclei in various stages of fusion. The new sporophyte, which often remains attached to the empty oogonium, grows rapidly, is positively heliotropic, and by vegetative structure and by staining (with polychrome methylene-blue) can be readily distinguished from the gametophytes. The first rhizoid appears early. The gametophytes of *Chorda* are much larger and further developed, but take a much longer time to mature; and the critical stages are much more difficult to observe. Also the mode of emergence of the egg is very different from that of *Laminaria*; the oogonial wall thickens but little, its outer layer bursts, and the contents, instead of emerging completely, grow out still enclosed in the extensible inner oogonial wall, the basal part thus remaining within the oogonial cavity. The young sporophyte accordingly is more securely anchored to the gametophyte than is the case in *Laminaria*; further it grows more rapidly than in that genus. There is in Laminariaceæ a pronounced alternation of generations, with a great reduction in the gametophytes. "The cases in *Laminaria* where the gametophyte consists of a single cell separated from the zoospore by a single nuclear division make it easy to adopt the suggestion that the so-called oogonia and antheridia in the Fucaceæ are sporangia. The systematic position of the group has to be changed; and we now get rid of the anomaly of regarding the alga which shows the highest advance in histological differentiation as a member of the

Phæozoosporeæ having only asexual reproduction. The investigation also furnishes material for further consideration of the much-debated question of the relations of *Chorda* to the other Laminariaceæ." A. G.

**Resistance of Marine Algæ to Cold.**—H. KYLIN (*Ber. Deutsch. Bot. Gesell.*, 1917, **35**, 370–84; see also *Bot. Centralbl.*, 1919, **140**, 135). An account of experiments on various marine algæ in certain degrees of cold water, maintained at a constant temperature. The algæ vary greatly. *Trailliella intricata* was killed after three hours' exposure to  $-2.9^{\circ}\text{C}$ .; while *Fucus vesiculosus*, *Nemalion multifidum* and others remained unharmed by ten hours in a temperature of  $-18^{\circ}$  to  $-20^{\circ}\text{C}$ . Between these extremes stand species of *Laminaria*. The young plants of *L. saccharina* are more sensitive than older plants. The author draws conclusions concerning algal distribution in Swedish waters. The determining factor is the sinking of the surface of the water in the winter, whereby the algæ are laid bare and exposed to the winter cold. The *Laminaria* species are only covered by 0.60–0.65 m.; and the same applies to the sensitive *Laurencia pinnatifida*. On the other hand, the cold-resistant *Fucus vesiculosus* and *Ascophyllum nodosum* can exist immediately below mid-tide mark at a depth of 0.5 m. The resistance of sensitive species was not raised by treatment with sugar solution and concentrated sea-water, which is probably explained by their extraordinary sensitiveness towards increase of concentration. The parallelism of sensitiveness towards cold and concentration points to the accuracy of the Müller-Thurgau theory—namely, that death from freezing is caused principally by the abstraction of water consequent in ice-formation. The sensitive *Trailliella* withstood a temperature of  $-4^{\circ}\text{C}$ . for two hours without the slightest damage, provided no formation of ice took place.

E. S. G.

**Tyson Collection of South African Marine Algæ.**—E. M. DELF and M. R. MICHELL (*Annals Bolus Herbarium*, 1921, **3**, 89–119). A list of species represented in the herbarium of the late Mr. W. Tyson, which is preserved in the Bolus Herbarium and is composed almost entirely of specimens from the shores of the Cape Province and Natal, chiefly from Algoa Bay, the Kowie, Kei Mouth and the Cape Peninsula. Incorporated in the list are personal observations made on dried and fresh material. The distribution of the species is affected by the difference of temperature of the water on the two sides of the Cape Peninsula; and also probably by the different formation of the fore-shore, which has rocks mainly of sandstone on the eastern side and often of granite on the west. The algæ of the west coast are however less accessible, and have been insufficiently studied, making a comparison of the two sides at present impossible.

E. S. G.

**Algæ Mildbraedianæ Annobonenses**—R. PILGER (*Engler's Bot. Jahrbuch*, 1920, **57**, 1–14, figs. in text; see also *Hedwigia*, *Beiblatt*, 1921, **62** (88). An account of the marine algæ collected by J. Mildbraed in 1911 on the island of Annobon off the Guinea Coast, West Africa. Seven new species and one new variety are described, discussed and figured. *Caulacanthus fastigiatus* Kütz. is reduced to a variety of *C. ustulatus* Kütz.

E. S. G.

## Fungi.

**Technique in Contrasting Mucors.**—A. F. BLAKESLEE, DONALD S. WELCH and J. LINCOLN CARTLEDGE (*Bot. Gaz.*, 1921, **72**, 162-72, 2 figs.). A careful and detailed account of the methods employed in the study of the sexual relations between different races of mucors. The work must be carried out in cultures, and some of the sources of error due to faulty technique have been pointed out. The writers intend that the paper should serve as an introduction to a communication to be published later.

A. LORRAIN SMITH.

**Phytophthora sp. Injurious to Papaver nudicale in Victoria, Australia.**—C. C. BRITTLEBANK (*Journ. Dept. Agric. Victoria, Australia*, 1919, **17**, 1). It was found that 80 or 90 p.c. of specimens of *Papaver* were killed by this fungus. The disease usually becomes perceptible just when, or before, the buds form, and the plants attacked fail to flower. Spraying with copper-soda wash proved an effective remedy.

A. L. S.

**Blepharospora terrestris**, a Phycomycete parasitic on White Lupin, and new to Italy.—B. PEYRONEL (*Reale Accad. dei Lincei*, 1920, **29**, 194-7; see also *Bull. Agric. Intell. and Pl. Diseases, Rome*, 1920, **11**, 1058-9). The fungus has been found on the roots and hypocotyl region of *Lupinus albus*. When the dead plants were examined the author found mycelium in the root tissues, while in the cortical tissues there were large numbers of oogonia and ripe oospores.

A. L. S.

**Sexual Dimorphism in Cunninghamella.**—A. F. BLAKESLEE, J. LINCOLN CARTLEDGE, and DONALD S. WELCH (*Bot. Gaz.*, 1921, **72**, 185-219, 1 fig.). The discussion in the present paper is confined to *Cunninghamella*. In the species of that genus there is apparent a graded series so far as the strength of sexual activity is concerned from sexually strong to sexually weak races. The authors conclude from research and observation that *Cunninghamella* is sexually dimorphic.

A. L. S.

**Massachusetts Species of Helvella.**—P. J. ANDERSON and MARGUERITE G. ICKIS (*Mycologia*, 1921, **13**, 201-29, 2 pls.). The authors give a preliminary history of the genus and of the literature. They decide to abide by the name *Helvella*, that being the one used by Persoon and Fries. A synoptic key of the eleven species found in the State of Massachusetts and full descriptions are given.

A. L. S.

**Studies in Entomogenous Fungi.**—T. PETCH (*Trans. Brit. Mycol. Soc.*, 1921, **7**, 89-167, 3 pls. (2 col.)). Petch begins with a historical account of the *Nectriæ* parasitic on scale insects, the first having been described in 1848 by Desmazières on the scale insects of willows at Caen, France. The fungus was named *Microcera*: it is the conidial stage of *Sphærostilbe*. A list is given of all the *Nectriæ* that have been recorded on scale insects, and the genera in turn are dealt with. These fungi abound in the tropics. Petch has added the following new

genera :—*Podonectria* (with the conidial stage *Tetracrium*), *Pseudo-microcera* and *Discofusarium*. On two plates the brightly coloured fungi are depicted; a third plate gives microscopic drawings of spores, etc. A. L. S.

**Hansen's Curve for the Sporulation of Yeasts.**—H. KUFFERATH (*Bull. Cl. Sci. Acad. Roy. Belg.*, 1921, 7, 332-56). By means of cultures Kufferath has studied the sporulation of yeasts in cultures. He used cultures differing from those employed by Hansen to determine the first appearance of spores and the maximum of sporangia. He distinguishes three factors: (1) time, (2) temperature, and (3) "some factor which expresses the apparition or the production of some well-determined phenomenon in the life of the organism." The author gives the subject a very wide application to biological life. A. L. S.

***Pythium Butleri* sp. n., a Peronosporaceous Parasite of Various Cultivated Plants in India.**—I. S. SUBRAMADAN (*Mem. Dept. Agric. India, Bot. Ser.*, 1919, 10, 181-94, 6 pl.). This fungus has caused much damage in nurseries of tobacco and pepper plants in Pusa, etc. The disease has also been found on pimento and on the papau tree. Inoculation proved that *Pythium Butleri* was in each case the cause of the withering and rotting. Various remedies are suggested. A. L. S.

**Memoranda and Index of Cultures of Uredineæ, 1899-1917.**—T. C. ARTHUR (*Mycologia*, 1921, 13, 230-62). The author gives a summary of this cultural work on Uredineæ over a period of nineteen years at Purdue University. During the progress of the work he alone, or with an assistant, made many excursions over a large part of the States. Much new work was done on *Gymnosporangium*, though most attention was given to sedge and grass rusts. As a result of cultures sixteen species were described as new. A summary of all the cultures is tabulated and a fungus as well as a host-index is given. A. L. S.

**Reaction of F<sub>2</sub> Wheat to Rust.**—G. F. PUTTICK (*Phytopathology*, 1921, 11, 205-13). Crosses were made between *Triticum durum* and *T. vulgare*, and the F<sub>2</sub> generation was tested by various biologic forms of *Puccinia graminis*. The two crosses of the hosts were found to react reciprocally to the two rusts. Seedling plants were infected easily, but the biologic forms of the host were constant in their degrees of susceptibility, and it is concluded that varieties of wheat immune to infection may be cultivated. A. L. S.

**Self-sown Wheat in Relation to the Spread of Rust in Australia.**—W. L. WATERHOUSE (*Agric. Gaz. New South Wales*, 1920, 31, 165-6). In June the plants of self-sown wheat were found to be badly rusted by *Puccinia graminis* in the uredo and telento stages, while no sign of the fungus was found on the cultivated crop. At the end of August self-sown wheat was badly rusted by *Puccinia triticea*. The observations are far from complete, but they show the importance of self-sown wheat as an agency in the spread of rust by means of uredospores. A. L. S.

**Notes on New or Rare Species of Rusts.**—W. H. LONG (*Bot. Gaz.*, 1921, 72 (39-44)). The author has described four new species: *Gymnosporangium* on a *Cupressus* from Arizona, and three species of *Ravenelia* on *Leguminosæ* from Texas, and also notes on two other *Raveneliæ*. He found that in June, 1920, very few of these rusts were to be found in Texas in localities where hundreds of infected plants were present in May and November of 1916. He concludes that certain seasons must be more favourable than others for the propagation and dissemination of these rusts. A. L. S.

**Germination of Æciospores, Urediniospores, and Teliospores of *Puccinia coronata*.**—G. R. HOERNER (*Bot. Gaz.*, 1921, 72, 173-7). The crown-rust of oats is important economically, and the problem of its dissemination and continuance has attracted numerous workers. Hoerner has found that aeciospores on *Rhamnus* remain viable in the herbarium 167 days from the date of collection. The uredospores lasted about half the time; exposed to light they lost viability in 23 days, while in the dark they were capable of germination after 79 days. Telentospores did not germinate without overwintering. A. L. S.

**Graphiola and Farysia.**—ED. FISCHER (*Ann. Mycol.*, 1920, 18, 188-97, 7 figs.). Fischer has subjected these two genera to critical examination, and has discussed fully their systematic position. He establishes a family, Graphiolaceæ, with two genera, *Graphiola* Poit. and *Stylina* Sydow, which differ as regards peridium and spores. He gives further the results of an examination of *Farysia*. These genera have been associated with the Ustilagineæ. Fischer does not think our knowledge of these fungi is complete enough to make a decision possible as to their true systematic position. A. L. S.

**Notes on Uredineæ.**—H. SYDOW (*Ann. Mycol.*, 1921, 19, 161-75). The author passes in review the old-established genera of the Uredineæ. He finds that a number of species in these genera show divergent generic characters, and he proposes new genera for their inclusion. He establishes and describes nineteen genera in addition to those previously classified. A. L. S.

**Present-day Knowledge of the Distribution of the Anther Smut (*Ustilago violacea*).**—HERMANN ZILLIG (*Ann. Mycol.*, 1920, 18, 136-53). This smut is confined to the Caryophyllaceæ, and is found over all the world where these plants inhabit. The one exception is Australia, where the *Sileneæ* are the chief hosts of the fungus. The author gives all the references to localities that he has been able to determine, and also a full bibliography with a list of the herbaria examined. A. L. S.

**Mycological Contributions to the Flora of Moravia and Silesia.**—J. WEESE (*Ann. Mycol.*, 1920, 18, 161-77). The author gives an account of collections made in the region, chiefly by Niessl. The fungi listed are all micro-fungi, many of which are fully described, and valuable biological and literary notes are added. A. L. S.

**Homothallism and the Production of Fruit-bodies by Monosporous Mycelia in the Genus *Coprinus*.**—IRENE MOUNCE (*Trans. Brit. Mycol. Soc.*, 1921, 7, 198–217, 2 pls.). The author has followed on the lines of investigation of Bensaude and Knief. Bensaude discovered that in certain species mycelium produced from one spore would not develop fruit-bodies; whereas the mycelia from two or more spores fused and formed clamp connexions and conjugate nuclei. Mounce has found in the genus *Coprinus* that in some species there is development of fruit-bodies from one spore, while in others a mixture of mycelia is necessary—i.e. some are homothallic, others heterothallic. A list of the fungi experimented with is given, the methods are described, and the results set out in detail. A. L. S.

**Mycological Contributions. I.**—F. PETRAK (*Hedwigia*, 1921, 62, 282–319). Petrak publishes a critical survey of a large number of herbarium microfungi. He finds reason to establish new genera for a series of these fungi: *Khekia* based on *Calospora ambigua*; *Allantoportha* on *Diaporthe tessella* Rehm; *Discodiaporthe* on species of *Diaporthe*; *Botryosphæostroma* on *Fusicoccum Ellisi*; *Diploplacosphæria*, a new discovery, a stage form of some Dothideaceæ; and *Glæosporidiella* on *Glæosporium ribis*. A. L. S.

**Imperial Bureau of Mycology.**—E. J. BUTLER (*Trans. Brit. Mycol. Soc.*, 1921, 7, 168–72). The paper sets forth the reasons why a bureau was established at Kew—its aims and achievements. Its chief functions are: the accumulation and distribution of information; publication of abstracts; formation of a library; identification of fungi; study of parasitic fungi; formation of a herbarium of parasitic fungi; provision of laboratory facilities; control agency on matters suitable for legislation; and, finally, the stimulation of other branches of mycology as opportunity arises. A. L. S.

**New Fungi. XVI.**—H. and P. SYDOW (*Ann. Mycol.*, 1920, 18, 154–60, 1 fig.). A descriptive list of microfungi from many localities in Europe and beyond. All of them are new to science. A. L. S.

**Notes on Some Interesting or Little-known Fungi.**—H. and P. SYDOW (*Ann. Mycol.*, 1920, 18, 178–87). The authors are dealing with fungi already published. For *Æcidium echinaceum* Berk., from Ceylon, they propose a new genus *Xenostele*. They criticize Lloyd's notes on *Paulia resinacea*, and point out that the name *Paulia* already exists as a genus of Pyrenopsidaceæ. They propose *Xenostoma* to replace *Paulia*, and a new genus of Hypocreaceæ, *Apiocrea*, distinguished by the form of the spores. A. L. S.

**Fungi Sinenses Aliquot a Cl. Prof. Otto Reinking collecti et communicati.**—P. A. SACCARDO (*Philippine Journ. Sci.*, 1921, 18, 595–605). A list of microfungi from various districts in China. Habitat and localities are given, and descriptions in the case of new species, of which there are a fair number. A. L. S.

**Mycological Notes. III.—F. PETRAK** (*Ann. Mycol.*, 1921, 19, 176–221). The author publishes critical notes on a large number of microfungi already known and described. He defines their systematic position, adds synonyms and gives biological details. He finds occasion to describe a number of new genera based on species already described. These are: *Neohendersonia*, *Placonemina*, *Cucurbitodithis*, *Glaeosporidina* and *Discosporopsis*. Several species new to science are also described.

A. L. S.

**J. Bornmüller's Macedonian Plants: Fungi.—H. SYDOW** (*Ann. Mycol.*, 1921, 19, 243–54). The plants were collected by J. Bornmüller while serving on the "*Landeskundlichen Commission von Mazedonien*," during 1917, 1918. With very few exceptions the fungi secured are microfungi, most of them Uredineæ, three of which are new to science. One Mycetozoon is listed, *Stemonitis ferruginea*.

A. L. S.

**Mycological Work of Josef Jahn, a Contribution to the Fungus-flora of the Egerland.—F. PETRAK** (*Ann. Mycol.*, 1920, 18, 105–35). After Jahn's death his mycological collections were sent to Petrak, who has examined them, and now publishes the results. He gives first a sketch of the botanical activity of Jahn, who botanized mainly in Eger (Bohemia). Though the list is not a very long one it contains some rare species (several of them determined by Petrak are new to science) and one new genus, *Jahniella* (Sphaeropsidæ). The list includes only microfungi.

A. L. S.

**Protection against Fungi from Abroad.—N. L. ALCOCK** (*Journ. Agric.*, 1921, October, 28, 5 pp., 5 figs.). The writer calls attention to the danger of allowing plants already contaminated with fungus diseases to enter the country. The chief source of new diseases to be feared is America, as those of Europe have already appeared here. "Chestnut blight," "black knot" of plum and cherry, and "fire blight" in apple are especially to be guarded against. Descriptions and figures of these are given.

A. L. S.

**Lichen Parasites and Lichenoid Fungi.—KARL KEISSLER** (*Ann. Naturhist. Mus. Wien*, 1921, 70–9). The author gives descriptions and notes of a number of species, most of them already described. There is one new genus and species, *Mycarthopyrenia Sorbi* Keissl. The perithecia resemble those of *Arthopyrenia*, but without gonidia. A useful index of the species referred to in the text is appended.

A. L. S.

**Longevity of Spores.—R. LESLIE COLLETT** (*Trans. Brit. Mycol. Soc.*, 1921, 7, 217–8). Collett obtained a small portion of a sooty deposit on bark issued as *Cladosporium fumago* in 1854. By careful and ingenious treatment, which is fully described, the fungus was induced to grow, so that the spores had retained viability for sixty-seven years in the dry conditions of a herbarium specimen. A. L. S.

**Sap Stain Fungi.—ERNEST E. HUBERT** (*Phytopathology*, 1921, 11, 216–24, 1 pl., 4 figs.). The author studied two fungi that stain wood—*Lasiosphaeria Pezizula*, which produces a grey stain in red-gum,

persimmon, beech, etc.; and *Ceratostomella* spp., which cause a blue coloration in various Coniferae. The hyphae of these fungi were traced in the different tissues, and their effect on the host observed. In practice it has been found that blued wood is apt to fail while undergoing steam bending.

A. L. S.

**Study on Hydrotropic Bending in *Phycomyces nitens*.**—HEINRICH WALTER (*Zeitschrift Bot.*, 1921, 11, 673-718, 6 figs.). The author has followed up Blaauw's study on the influence of light, by corresponding observations on the influence of moisture. The stalk of *Phycomyces nitens* is extremely susceptible to such influence, and the amount of curvature varies according to the amount of moisture, etc., present. Old and weak stalks are most easily affected. The author gives a long discussion on the significance of the facts.

A. L. S.

**Edible and Poisonous Fungi.**—A. MAUBLANC (*Paul Lechevalier*, 1921, Paris, pp. ciii, 110, col. pls. 96, 80 figs.). A short and clear account both scientific and popular, of fungi that are fit for food and those that are definitely harmful. The writer outlines the general characters of fungi, their geographical distribution, locality and habitat, with the season of growth. There is also a general classification, and accounts of the nature of the poisonous species, advice as to the collection and preparation of edible forms, with a note on their culture. The more special descriptions accompany the coloured plates. An index of French, German, English, Italian and Spanish popular names is appended.

A. L. S.

**Parasite on *Cupressus* spp. in S. Africa.**—A. M. BOTTOMLEY (*S. African Journ. Sci.* 1919, 15, 613-7, 4 pls.; see also *Bull. Agric. Intell. Pl. Diseases Rome*, 1919, 11, 401). The parasite caused a disease on young plants of *Cupressus*. Three fungi were found: *Pestalozzia* sp., *Phoma* sp., and a second *Phoma* with large fusiform spores which was proved by inoculation experiments to have caused the disease. The same *Phoma* has been described on *Juniperus* spp.

A. L. S.

**Two new Sclerotinia Diseases.**—B. F. DANA (*Phytopathology*, 1921, 11, 225-8, 6 figs.). The writer describes from nature and from culture experiments two new parasitic fungi; *Sclerotinia gregaria* on leaves and fruits of *Amelanchier Usickii* and *S. demissa* on *Prunus demissa*.

A. L. S.

**Studies in the Valsa Apple-canker in New Mexico.**—LEON H. LEONIAN (*Phytopathologist*, 1921, 11, 236-43). The canker attacks the twigs, the branches, and the main trunks of young and old apple-trees. The cause of the canker has been traced to the fungus *Valsa leucostoma*, most frequently found in the pycnidial stage, *Cytospora leucostoma*. The different stages were reproduced in artificial media.

A. L. S.

**Helminthosporium sp. the Cause of "Foot-rot" of Wheat in Illinois, U.S.A.**—F. L. STEVENS (*Science*, 1920, 51, 517-8). The fungus emanates from the soil, and had not hitherto been classified as causing "foot-rot." The fungus may also be carried by the seed.

A. L. S.

**Rosellinia Pepo, an Ascomycete Injurious to Cacao in Trinidad, West Indies.**—W. NOWELL (*Bull. Dept. Agric. Trinidad and Tobago*, 1920, 18, 178-99, 5 figs.). An account is given of several diseases of plants due to some species of *Rosellinia*. *R. Pepo* attacks cacao, and in most cases passes to the cacao from the roots of dead or dying shade trees. It also attacks *Citrus aurantifolia*, while *R. bunodes* causes a disease of coffee. The fungus penetrates the bark and wood, and may quickly cause the destruction of the tree by destroying the bark round the collar. Remedies are suggested.

A. L. S.

**Presence of Oak Oidium in Brazil.**—A. PUTTEMANS (*Bull. Soc. Path. Vég. France*, 1920, 7, 37-40; see also *Bull. Agric. Intell. and Pl. Diseases Rome*, 1920, 11, 1061-2). The *Oidium* was first observed in São Paulo in 1912, on trees of *Quercus pedunculata* of about fifteen years of age. The fungus itself was parasitized by *Cincinnobolus Cesatii*. The disease had been discovered six years previously in Europe, and the mode of its introduction into Brazil is discussed. The author thinks it may have passed by way of Madeira, where it was reported in 1908.

A. L. S.

**Investigation of some Tomato Diseases.**—F. T. BROOKS and G. O. SEARLE (*Trans. Brit. Mycol. Soc.*, 1921, 7, 173-97). The authors have been studying the various fungi that do damage to tomatoes. A list of the forms with which they dealt and the cultural and other experiments are described. Several of the forms under examination were identical with those described from American States. The synonymy of several species has been cleared up, and our knowledge of the parasitic fungi placed on a clear basis.

A. L. S.

#### Lichens.

**Methodical bases of Modern Plant Sociology.**—G. EINAR DU RIETZ (*Upsala*, 1921; *Wien, Adolf Holzhausen*, 1921, 272 pp., 38 tables, 22 figs.). The author has given a historical account of the study, Ecology (Plant Sociology), in the different schools of Europe and America, reviewing all the literature and the different systems. He gives results of his own examination of various localities in Sweden, and describes his methods and results. Particular attention is paid to Lichen associations either in conjunction with other vegetation such as *Deschampsia flexuosa*—*Cladonia rangiferina-silvatica*, etc., or as almost purely lichen associations the names of which indicate the dominant species as "constant," and these he lists in full. The *Parmelia omphalodes* association he found included two mosses and fifty-nine other lichens, several of them constant variants. Another prominent association, which occupies dry mountain ridges, he designates the *Lecanora deusta* ass.; with it as a constant is *Lecidea rivulosa*. Later he refers to a "*Lecidea rivulosa* association," with these are associated many crustaceous lichens which cover large areas. "*Lecanora quartzina* association" occupies a zone of sea-coast rocks exposed to storms. The author gives a critical résumé of the methods and aims of plant sociologists and appends a long and more or less complete bibliography.

A. LORRAIN SMITH.

**Lichens in the Herb. Gunnerus.**—BERNT LYNGE (*Kgl. Norske Vidensk. Selsk. Skr.*, 1920, N. 3, 12 pp.). Gunnerus was bishop in Trondhjem from 1758 to 1773. His diocese was large, and as he travelled from one place to another he collected natural history and other specimens; lichens form a small part of his herbarium and are listed in the order of their collection. Lynge has gone over the plants and publishes the bishop's names and numbers with his own notes and modern determinations.

A. L. S.

**Lichens of Pas-du-Calais.**—BOULY DE LESDAIN (*Bull. Soc. Bot. Fr.*, 1920, 67, 217-28). The author collected during several months on the dunes and in various inland districts. The species listed are often accompanied by biological notes. Lesdain gives, for instance, an account of *Ramalina farinacea*, which grew out from *R. calicaris*, probably due to very close association from an early stage of development; he has noted similar cases in *Uladonia*. A list is given of species found on unusual substrata, such as bones, iron, leather, etc.

A. L. S.

**Lichens from the Neighbourhood of Versailles.**—BOULY DE LESDAIN (*Bull. Soc. Bot. Fr.*, 1921, 68, 16-24). The list forms the final supplement to lichens already published from Versailles: some are new to the district; others had already been recorded. The author adds a list of microfungi which he found during his search for lichens.

A. L. S.

**New Lichens. IX.**—A. ZAHLBRUCKNER (*Ann. Mycol.*, 1921, 19, 224-42). The author describes twenty-five new species of lichens belonging to many different genera and from widely different localities—from Mexico, West Indies, East and West Africa, etc. One of the most notable is *Caloplaca teloschistoides*, with an upright branching thallus in tufts up to 40 mm. high. As the thallus has no cortex Zahlbruckner classifies it under *Caloplaca* rather than *Teloschistes*.

A. L. S.

**Lichenological Notes. XVIII.**—BOULY DE LESDAIN (*Bull. Soc. Bot. Fr.*, 1921, 68, 203-7). The paper consists mostly of diagnoses of new species from various countries—Switzerland, Portugal, Italy, N. America. One new genus has been determined, *Henrica*, distinguished by the rosulate thallus which in age forms podetia about 2.5 mm. high. The apothecia bear large brown muriform spores.

A. L. S.

**Lichens from the Gjøl Expedition.**—BERNT LYNGE (*Vid.-Selek. Skr.*, 1921, 1, *Mat. Naturv. Kl.*, N. 15, 7 pp.). A small collection was made during the above expedition to the North-West Passage, by Henrik Adolf Lindström. The lichens were found mostly at Gjøl Harbour and at Herschel Island. One new *Lecideu* was determined.

A. L. S.

**Swedish Xanthoriæ.**—G. EINAR DU RIETZ (*Svensk. Bot. Tidsk.*, 1921, 15, 181-91). The author notes that Th. Fries included three species in his "Lichenographia Scandinavica"; he himself adds several species to the flora. Various localities are given for *Xanthoria fallax*.

A. L. S.

**Studies of the Lichen Flora of Norway.**—BERNT LYNGE (*Videnskaps. Skrifter.*, 1921, 1, *Mab. Naturv. Klasse*, N. 7, 252 pp., 13 maps, 5 figs.). In a preface to this work Lyngé gives a short statement of Norwegian Lichenologists and of the districts in which they collected; he also gives an account of the economic use of lichens in Norway, of their distribution, and of the species characteristic of certain localities. In the special part are listed the lichens of the country; in each case is noted the districts where the flora was found as well as the collector. Biological notes and diagnoses are frequently added; this section of the work takes us from *Tholurna* and *Sphærophorus* to *Xanthoria*, twenty-five genera having been dealt with. A final chapter gives an account of Lapponian lichen names. A. L. S.

#### **Mycetozoa.**

***Arcyria virescens* sp. n.**—A. LISTER (*Journ. Bot.*, 1921, 59, 252-3). The new species was found by I. H. Burkill on a block of wood in the orchid pits of the Botanical Gardens, Singapore. It has also been collected at Naboda, Ceylon, and in the southern part of the Malay Peninsula. The species has also been found in the Kew Herbarium, collected in North Queensland over forty years ago. The new mycetozoon is well characterized by the capilitium and by the persistently green spores. *Arcyria glauca* also has green spores, but the two species are quite distinct. A. L. S.

## MICROSCOPY.

**The Reaction of the Eye to Light.**—PRENTICE REEVES (Research Laboratory, Eastman Kodak Co., N.Y.), (*Transactions of the Optical Society*, **22**, No. 1, 1920-21).

**Classification and Nomenclature of Optical Glass.**—GEORGE W. MOREY (*Journal of the Optical Society of America*, July, 1920, **4**, 205-12).

**A Note on the Annealing of Optical Glass.**—L. H. ADAMS and G. D. WILLIAMSON (*Journal of the Optical Society of America*, July, 1920, **4**, 213-23).

**Optical Properties of Anthophyllite.**—N. L. BOWEN (*Journal of the Washington Academy of Sciences*, **10**, No. 14, August 19, 1920).

**Dispersion in Optical Glasses.**—F. E. WRIGHT (*Journal of the Optical Society of America*, May and July, 1920, **4**, 148-59, 195-204).

**Certain Relations between Chemical Composition and Refractivity in Optical Glasses.**—F. E. WRIGHT (*Journal of the American Ceramic Society*, **3**, No. 10, October, 1920).

**Optical Glass and its Future as an American Industry.**—ARTHUR L. DAY, Ph.D., Sc.D. (*Journal of the Franklin Institute*, October, 1920).

**The Unaided Eye. Part III.**—JAMES WEIR FRENCH, B.Sc. (*Transactions of the Optical Society*, **21**, No. 4, 1919-20).

**The Rock-Crystal of Brazil.**—ROBERT R. WALLS, M.A. B.Sc. (*Transactions of the Optical Society*, **21**, No. 4, 1919-20).

## METALLOGRAPHY.

**Constitution of Tungsten and Molybdenum Steels.**—A. M. PORTEVIN (*Iron and Steel Inst. Meeting*, September, 1921). Extremely slow cooling is shown to effect in the disappearance of obviously hard states, and the structures generally supposed to be in equilibrium are then superseded by others characteristic of a still more advanced condition of stability. In Tungsten steels, the structure consists of a tungstitic ferrite, a tungsten carbide, a tungstitic troostite, and a new constituent—complex ferrite +  $\text{Fe}_2\text{W}$ . There are, however, only three phases—a solid solution, a tungsten carbide, and the compound  $\text{Fe}_2\text{W}$ . A more highly carburized, though analogous constituent, is found in the case of Molybdenum steels.

F. I. G. R.

**Coalescence in Steels.**—A. PORTEVIN and V. BERNARD (*Iron and Steel Inst. Meeting*, September, 1921). The authors point out that coalescence between similar phases of a system is a natural phenomenon which appears to be closely connected with the general tendency for the energy of such a system to become a minimum. The results of this habit are depicted in a really beautiful series of photomicrographs, showing characteristic structures of coalescence under different magnifications and with various etching reagents.

F. I. G. R.

**Mechanical Properties of Steels at High Temperatures.**—E. L. DUPUY (*Iron and Steel Inst. Meeting*, September, 1921). The object of this research is the determination of the mechanical properties of steels in respect of their carbon percentages at all temperatures between the normal and incipient fusion. Both rolled and cast material were used for studying effect of grain-size and orientation. The author makes the interesting observation that Armco Iron (carbon less than 0.02 p.c.) is incapable of forging or rolling between 850° and 990° C. Several plates of photomicrographs are included. A particularly valuable feature is the use of a solid (i.e. three-dimensional) model illustrating the relationship existing in such samples between temperature, carbon content, and reduction of area. Such models, representing states of equilibria between the constituents of ternary alloys, have been used in this country by Prof. Desch and others, but the extension of the system to the case of mechanical variables is interesting and worthy of attention; more especially if the model is used in connexion with the study of the microphotographs given in the paper. The author gives the results of his investigations in terms of well-defined "regions" of the iron-carbon equilibrium diagram.

F. I. G. R.

**Damascene Steel.**—N. T. BELAIEV (*Iron and Steel Inst. Meeting*, September, 1921). The author considers that there is a marked analogy between high-speed and damascene steels, and proceeds to a fairly detailed comparison. Damascene steel belongs to the hyper-eutectoid variety—in many samples the carbon content is about 1.5 p.c. Accompanying the paper is a remarkable photograph (under high magnification) depicting the structure of an Indian blade, showing globules of spheroidized cementite embedded in a sorbitic matrix.

F. I. G. R.

**Magnetic Separation of the Lines of Iron, Nickel and Zinc in Different Fields.**—K. YAMADA (*Journ. Coll. Sci. Tokyo*, 1921, 41, Art. 7). The object of the investigation was to determine whether the separations of Fe and Ni were proportional to the fields applied. Photographs show separations of their outer two components proportional to the fields applied. In the case of zinc ( $\lambda : 3345.13$ ) the separation is a linear function of the field.

F. I. G. R.

**Magnetic Separations of Iron Lines in Different Fields.**—Y. TAKAHASHI (*Journ. Coll. Sci. Tokyo*, 1921, 41, Art. 8). Many sharp lines give separations proportional to the magnetic field as if

there was no mutual influence between the radiating electrons. The divergent values of the specific separations seem to indicate the existence of coupling.

F. I. G. R.

**Electro-deposition in Aeronautical Engineering.**—W. A. THAIN (*Trans. Faraday Soc.*, 1921, 16, part 3). Plating has been shown to increase the thermal conductivity. Microphotographs are given showing the appearance of the deposit in different cases.

F. I. G. R.

**Maximum Current Density in Silverplating.**—F. MASON (*Trans. Faraday Soc.*, 1921, 16, part 3). Manufacturers require that a characteristic mirror-like finish should be obtained with a minimum of labour after plating. Microscopical investigation shows that this ideal condition is largely governed by the size and position of the crystals of the deposit.

F. I. G. R.

**Failure of Lead Sheathing of Electric Cables.**—L. ARCHBUTT (*Trans. Faraday Soc.*, 1921, 17, part 1). A very interesting series of microphotographs exhibiting cases of incipient intercrystalline fracture. An alloy of lead with 3 p.c. of tin has a much finer structure than ordinary lead, and seems less likely to undergo intercrystalline failure.

F. I. G. R.

**Fractures in Locomotive Boiler Tubes.**—H. FOWLER (*Trans. Faraday Soc.*, 1921, 17, part 1). A set of photomicrographs shows impurities trapped between the crystal-boundaries, the fractures being generally intercrystalline. The tubes concerned were lap-welded.

F. I. G. R.

**Inter-crystalline Fracture in Steel.**—D. HANSON (*Trans. Faraday Soc.*, 1921, 17, part 1). Several cases have been observed in steel boiler plates which have failed in service. The examples given appear to indicate that such failure can occur solely as the result of the internal or external stresses to which the material is subjected.

F. I. G. R.

**Inter-crystalline Cracking of Mild Steel in Salt Solutions.**—J. A. JONES (*Trans. Faraday Soc.*, 1921, 17, part 1). The paper describes the action of various solutions of calcium, ammonium and sodium salts in producing cracking of steel in a state of stress.

F. I. G. R.

**Mechanism of Failure of Metals from Internal Stress.**—W. H. HATFIELD (*Trans. Faraday Soc.*, 1921, 17, part 1). Except in certain cases where collective chemical or physico-chemical action causes a separation of the remains of crystals from each other, fractures such as discussed in this paper are due to internal stresses introduced during manufacture. Important information is given on the subject of rust, both in water and in the atmosphere. In all cases the effect proceeded indiscriminately over the surfaces, no case of local corrosion at the crystal boundaries being observed.

F. I. G. R.

**Internal Structure in Relation to Microstructure.**—J. C. W. HUMFREY (*Trans. Faraday Soc.*, 1921, 17, part 1). In a bar built up of two materials possessing different mechanical properties, uniform straining sets up stresses which produce asymmetry in the position of elastic limits. A remarkable photomicrograph showing the deformation of pearlite is given, illustrating the bending up of the lamellæ.

F. I. G. R.

**Internal Fracture in Steel Rails.**—H. S. RAWDON (*Trans. Faraday Soc.*, 1921, 17, part 1). A magnetic method for locating internal defects is described, together with the microscopic appearance of internal cracks in rail steel.

F. I. G. R.

**Internal Stress Irregularities.**—J. N. GREENWOOD (*Trans. Faraday Soc.*, 1921, 17, part 1). The possible origins of internal stresses in pure metals and alloys are examined. They are (1) due to cold working; (2) suppression of phase changes by rapid cooling. The case of tool steels receives special attention.

F. I. G. R.

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## ULTRAMICROSCOPY, COLLOIDS, Etc.

**Physics and Chemistry of Colloids.**—THE SVEDBERG (*Trans. Faraday Soc.*, 16, part 3, 1921). The author, one of the greatest exponents of colloidal physics, gives a brief but comprehensive account of the present state of knowledge on this subject, and insists that nearly every property of a colloid depends upon its structure, the most direct way of observing which is the ultramicroscope, and to some extent the ordinary microscope. By such means it is often possible to decide whether the phase in question is grainy, foamy or fibrous. The number and size of the particles can also be found in this way. It is to be remembered that the ultramicroscope gives practically no information about the form of the particles themselves. In the event of the particles being too small to be measured directly by the ultramicroscope, it may be possible to measure their size by depositing gold upon them. The instrument may also be employed to observe the aggregation process in the case of secondary gels and sols. The author considers that there is a promising field for the development of colloids in industry.

F. I. G. R.

**Reversal of Phases in Emulsions.**—S. S. BHATNAGAR (*Trans. Faraday Soc.*, 16, part 3, 1921). A microscopical method is described for determining the type of emulsion, by means of the "colour-indicator" process, in which use is made of some soluble oil dye. In the case of an oil-in-water emulsion the colour remains confined to the particles of oil which exist as globules, but in water-in-oil emulsions the colour covers the surface of the continuous phase. Certain difficulties in connexion with the method are discussed.

F. I. G. R.

**Reversible Sol-gel Transformation.**—S. C. BRADFORD (*Trans. Faraday Soc.*, **16**, part 3, 1921). There is considerable evidence from microscopical work for regarding the reversible sol-gel transformation as an extreme case of crystallization due to the low diffusivity and minimum velocity of crystallization of the gel substance. F. I. G. R.

**The Structure of Gels.**—J. O. W. BARRATT (*Trans. Faraday Soc.*, **16**, part 3, 1921). Application of the ultramicroscope has resulted in the view that gels are sometimes structureless, and that when structure is observed it consists, not of liquid droplets enclosed by solid septa, but of a mass of intersecting fibrils. F. I. G. R.

**Precipitation of Disperse Systems.**—R. S. WILLOWS (*Trans. Faraday Soc.*, **16**, part 3, 1921). Zsigmondy finds it possible to distinguish ultramicroscopically between the yellow-green primary and secondary particles in a gold sol as follows. The number of primary particles per unit volume of a red-gold sol is counted, electrolyte is then added in "definite" volume. When a certain easily recognized colour tint appears a solution of gum arabic is added, preventing further coalescence. A recount is now made of the primary particles or the total number of particles, primary, secondary, etc., which can be compared with theory. F. I. G. R.

**Abnormal Crystallization of Lead Azide by Protective Colloids.**—A. G. LOWNDES (*Trans. Faraday Soc.*, **16**, part 3, 1921). A very beautiful series of microphotographs of lead azide crystals. Some of the crystals show very perfect twinning. The explosive nature of this compound can be gauged by the sharp acicular outline of the crystals. The effect of adding a colloid to the solution is to give much more rounded, and presumably stabler, forms. F. I. G. R.

**Colloids in Electro-deposition of Metals.**—W. E. HUGHES (*Trans. Faraday Soc.*, **16**, part 3, 1921). In some cases, contrary to the usual opinion, the use of a colloid makes it easier to obtain a smooth, coherent coating in electro-deposition. Microscopical examination shows that the deposit is really crystalline. The subject is one of some importance to industry. F. I. G. R.

## NOTICES OF NEW BOOKS.

**The Physical Properties of Colloidal Solutions.** By E. F. Burton, B.A., Ph.D. 1921. viii + 221 pp., 18 illustrations. 2nd edition. Published by Longmans, Green and Co., 39 Paternoster Row, London, E.C. Price 12s. 6d. net.

That Professor Burton's book should have reached a second edition already shows not only how rapidly the science of colloidal and molecular physics has advanced, but also that many research workers and students have found in it just the information which they needed. The ground covered is large, including the Brownian Movement, coagulation of colloids, together with a mass of detail dealing with optical properties, cataphoresis, endosmose, and kindred "borderland" subjects.

To microscopists the chapter dealing with the ultra-microscope will naturally appeal. Here we find the Helmholtz-Rayleigh and Abbé theories of resolution given due prominence (such fundamental concepts being far too often overlooked), together with the chief forms of ultra-microscopic illumination.

Stress is laid on the limitations of the ultra-microscope as an instrument of research, both from the point of view of ordinary observational work and in the domain of ultra-micrometry.

The mathematical treatment throughout the book follows along conventional lines; it suffers in part from being somewhat too restricted, especially in regard to Einstein's classical work on Diffusion, and the deductions of Helmholtz and Lamb with respect to cataphoresis. Again, though the subject is suggested, we are not given overmuch information about the range of validity of Stokes's Law (which has recently been called in question), a matter which concerns ultra-microscopists very deeply in their observations on the distribution of particles.

The volume teems with fascinating problems for workers in colloidal physics, but is one well worth the attention of microscopists; there is perhaps no greater need than the bridging of the gulf which tends to divide microscopists and physicists. How narrow the gulf really is Professor Burton shows with a conviction born of experience.

The book is well printed, and the diagrams are excellent, with the exception of Fig. 4, which is too small and obscure to be helpful.

The very compendious references to original memoirs are sure to be of great assistance both to microscopists and to those who study the subject of colloids for its intrinsic or industrial interest. F. I. G. R.

**Aggregation and Flow of Solids.** By Sir George Beilby, F.R.S. 1921. xvi + 256 pp., 34 plates. Published by Macmillan and Co., Ltd., London, W.C.2. Price 20s. net.

The reader will not have proceeded far with the study of this book without coming to the conclusion that it constitutes a labour of love on the part of the author, and to some extent of those who have been

associated with him, both in the experimental work and in the task of collecting such a mass of detailed records, extending over more than a couple of decades.

Sir George Beilby has made many branches of science his debtor: physics, metallography, microscopy, chemistry and geology, all sharing in the advance which has been made.

We are concerned more particularly with the first three. Research such as this book describes should go far to effect a closer union between physics and microscopy on the one hand, and the elucidation of the physical meaning of metallographical phenomena on the other. For instance, the rather cryptic statement of the physicist that a solid possesses energy by reason of its surface, receives new and abundant confirmation when we are told that "increase in the mobility of the molecules of a solid which is still far short of the freedom of the liquid state is sufficient to enable the force of surface tension to assemble the molecules of a thin film into new forms of aggregation."

The metallurgical reader will naturally turn to the section dealing with surface flow and the theory of polish; in these fields he will find that the author has indeed gathered a goodly crop of new knowledge. The true nature of the processes of abrasion, grinding and polishing is laid bare, and the usual opinion that the last-mentioned is only a particular case of the second, well refuted. Before leaving the study of metals, some views of very great interest are given on the vexed subject of hardening. Finally, the optical properties of thin films come in for their fair share of attention, thus carrying on the work begun by Faraday some seventy years ago, and published in his Bakerian Lecture of 1857. Throughout the book great stress is laid on the importance of a thorough appreciation on the part of the investigator of the possibilities and limitations of the microscope as an instrument of research, also the need for careful interpretation of results dependent upon resolving power and Numerical Aperture.

It seems ungracious to call attention to defects in a book such as this, except to show how few and unimportant they are. On page 10 there appears to be an editorial slip (and again later on) when the phrase "throughout the paper" occurs; a remnant, no doubt, of the memoir in which the observations were first published. The absence of an index is rather a pity, for the contents arranged at the beginning of each section do not facilitate ready reference very much; for a volume containing such a wealth of information should be in every library of reference.

It only remains to add a word of commendation to the publishers in producing a book worthy of the subject, well printed, and beautifully illustrated.

F. I. G. R.

# PROCEEDINGS OF THE SOCIETY.

## A SPECIAL GENERAL MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, W., ON  
WEDNESDAY, DECEMBER 21ST, 1921, AT 7.45 P.M., MR. A.  
EARLAND IN THE CHAIR.

It was moved from the Chair, and seconded by Mr. Hill, That the Society's By-laws be altered in the following manner:—

5. *To add*:—

“In cases which the Council regard as exceptional, the Council shall have power to dispense with this provision.”

10. *To insert* in the Declaration after the word “*power*”:—

“and will not use the Fellowship for the purpose of advertisement in trade or business.”

20. *To add* after the words “*admission fee of two guineas*”:—

“or such other sum as may be determined from time to time by the Council.”

24. *To read*:—

“The Council may remit all or *part* of the past or future annual subscriptions . . . *etc.*”

27. *To add*:—

“Fellows shall have the right to place the letters F.R.M.S. after their names for so long as they remain Fellows of the Society.”

29. *To add* after the words “*Honorary Fellows*”:—

“and Ex-officio Fellows.”

30. *To be deleted.*

After By-law 54 *to insert* a new Sub-section and By-law. [“*C. Special*”]:—

“The Council may concur with any other learned Society in promoting any object embracing the advancement of Microscopical and Biological Science upon such terms as the Council may consider advantageous to the Society.”

60. *Present By-law to be replaced by*:—

“The Treasurer shall keep in appropriate books proper and sufficient accounts in all necessary detail of the capital funds

and expenditure of the Society so that the true financial state and condition of the Society may be at all times exhibited by such accounts."

62. *Present By-law to be replaced by :—*

"The accounts shall be audited annually by a professional Accountant to be appointed by the Council. Such Accountant shall have power of calling for all necessary books, papers, vouchers and information."

76. *To add :—*

"or at such time and on such other date as the Council may appoint."

77. *To add after the words "course of business" :—*

"unless otherwise determined by the Council."

77. *To add to 2nd sub-clause :—*

"and New Fellows admitted to the Society by the President, Vice-President, or other Chairman of the Meeting."

79. *To add :—*

"or at such time and on such other date as the Council may appoint."

80. *To delete By-Law 80 down to and including the 7th sub-clause, and in place thereof insert :—*

"At this meeting the Council shall submit its Report of the Society's proceedings and the Audited Accounts of the Treasurer. The ballot shall take place for the election of the Council for the ensuing year and . . ."

86 and 101. *To insert after the words "Ordinary Fellows" :—*

"resident in the United Kingdom."

After By-law 86 *to insert* a new Section and By-law. ["VIII. *Sectional Meetings*"] :—

"Sectional meetings may be held by the Fellows at such times and under such regulations as may be determined from time to time by the Council."

88. *Present By-law to be replaced by :—*

"No instruments or other property shall be taken out of the Society's Rooms except under such regulations as may be determined from time to time by the Council."

Also to make such alteration to the numbering of the By-laws as may be necessary.

Carried *nem. con.*

---

The proceedings then terminated.

# AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT NO. 20 HANOVER SQUARE, W., ON  
WEDNESDAY, DECEMBER 21ST, 1921, AT 8 P.M., MR. A. EARLAND  
IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed by the Chairman.

---

The nomination papers were read of six Candidates for Fellowship.

**New Fellows.**—The following were elected Ordinary Fellows of the Society :—

Mr. Thomas Francis Connolly.  
Mr. Joaquin Diago, M.D., M.C.A., M.C.S., M.A.M.S.  
Mr. Leslie George Gilpin-Brown.  
Mr. John Manson, L.D.S.

---

**Donations** were reported from :—

British Museum—  
“Catalogue of Cretaceous Bryozoa.”  
“Handbook of British Lichens.” (A. L. Smith.)  
Macmillan and Co., Ltd.—  
“Aggregation and Flow of Solids.” (Sir G. Beilby.)  
Mr. H. Sutcliffe—  
“Brown Bast.”

A hearty vote of thanks was accorded to the donors.

---

**Exhibits** were shown by Dr. Murray and Mr. Conrad Beck, who were thanked from the Chair.

---

**Mr. Hiscott** and **Mr. Mortimer** were re-elected as Auditors for the ensuing year.

---

The names of Fellows nominated for the new Council were read.

---

The following papers were read :—

Dr. James G. Parker, F.I.C., F.R.M.S. (Principal of the Leathersellers' Technical College), and Dr. Sidney H. Browning, L.R.C.P., M.R.C.S., F.R.M.S.—  
“The Practical Value of the Microscope in Connexion with Leather Manufacture.”

Professor A. Gandolfi Hornyold, D.Sc., F.R.M.S.—

“The Age and Growth of some Eels from a Worcester-shire Pond.”

A hearty vote of thanks was accorded to the authors of the above papers.

The business proceedings then terminated.

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### THE ANNUAL MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, W., ON  
WEDNESDAY, JANUARY 18TH, 1922, PROFESSOR JOHN EYRE,  
PRESIDENT, IN THE CHAIR.

The **Minutes** of the preceding Special General Meeting and Ordinary Meeting were read, confirmed, and signed by the President.

The nomination papers were read of four Candidates for Fellowship.

**New Fellows** :—The following were elected Ordinary Fellows of the Society :—

Mr. Stanley Ernest Atwell, D.B.O.A.

Dr. John Alfred Barnes, M.D., M.R.C.S., L.R.C.P.

Mr. Humphrey John Denham, M.A.

Mr. E. Melville, DuPorte. M.Sc., Ph.D., F.E.S., etc.

Mr. Bossley Alan Rex Gater, B.A.

Mr. Geoffrey Harrington Sainsbury.

A **Donation** was reported from Messrs. R. and J. Beck, Ltd. (“The Microscope,” by Conrad Beck), and a vote of thanks was passed to the donors.

The **Death** of Sir German Sims Woodhead, who was President of the Society for the three years 1913, 1914 and 1915, was announced from the Chair. Those present rose in silence for a moment as a token of respect and sympathy.

Mr. Hill moved, and Mr. A. W. Sheppard seconded, “That the alterations in the By-Laws be hereby confirmed.” Carried.

THE ANNUAL REPORT of the Council for the year 1921 was read as follows :—

FELLOWS.

During the year 69 Ordinary Fellows have been elected and 1 reinstated. Reports have been received of the deaths of 7 Ordinary Fellows and 1 Corresponding Fellow. Ten Fellows have resigned and 18 have been removed from the Roll.

The number of Fellows at the end of the year 1921 was as follows :—

Ordinary	.	.	.	.	463
Honorary	.	.	.	.	17
Ex-officio	.	.	.	.	69
					<hr/>
					549

Of the Ordinary Fellows—

379 have paid the annual subscription.

33 have compounded.

2 have had subscriptions remitted.

The deaths reported above were those of—

Mr. C. E. Hanaman. Elected 1882.

Mr. G. E. Mainland. Elected 1884.

Mr. R. L. Mestayer. Elected 1884.

Mr. F. A. Parsons. Elected 1884.

Mr. C. F. Rousselet. Elected 1888.

Dr. E. J. Spitta. Elected 1903.

Dr. Henry Woodward. Elected 1880.

Professor Henry Hanks. Elected a Corresponding Fellow in 1874.

It will be noted with regret that during the year the Society has had the misfortune to lose a number of Fellows who, as important Officers, had rendered most valuable service to the Society.

FINANCE.

Owing to some delay in the publication of Part 4 of the Journal the accounts are held over until the next meeting.

JOURNAL.

An increasing demand for the Society's Journal shows that its standard of excellence is being maintained, and that its contents are appreciated in scientific circles. Further improvements and the extension of certain features are in contemplation, and it is hoped that these may add to its usefulness and influence.

The Council wishes to thank most cordially the Editors, Abstractors and Contributors for their valuable and much appreciated work during the past year.

## LIBRARY.

During the year 93 volumes have been borrowed from the Library by Fellows of the Society, in addition to 19 volumes that have been obtained from Lewis's Library for their use.

Donations to the Library have been received from—The British Optical Instrument Manufacturers, Mr. Paul Chevalier, Messrs. J. and A. Churchill, The Clarendon Press, Professor De Toni, Mr. S. H. Gage, Dr. H. Langeron, Messrs. Longmans, Green & Co., Messrs. Maclehouse, Jackson & Co., The Librairie Octave Doin, Dr. E. Penard, Mr. C. D. Soar, and Professor W. W. Watts, F.R.S.

A careful examination of the Society's Library has been made by the Honorary Librarian, and he has made certain recommendations which the Council have now under consideration with a view of increasing the usefulness of the Library and rendering it more easily available for the Fellows.

The special thanks of the Society are due to Mr. Martin Duncan for his services.

## INSTRUMENTS AND APPARATUS.

The Honorary Curator reports as follows :—

During the past year two Microscopes have been presented to the Society's Collection by Mr. C. D. Soar, one a Wilson Screw Barrel type, and one the property of the Physician to H.R.H. the Prince Consort. The latter is similar to the Tank Microscope of Ross manufacture, circa 1840.

Progress has been made in the compilation of the Catalogue of the Society's Instruments, and the part dealing with those in use up to the year 1750, together with the bibliography of the period, has now been completed. Photographs for purposes of illustration are now being made, and it is hoped to publish the same during the coming year.

The Society's Collection of Microscopes and Accessories is one of the most complete in existence, and illustrates the mechanical and optical development of the instrument.

It is regrettable that, instead of being permanently displayed, these instruments are crowded together in show cases which do not allow adequate facilities for examination. A scheme is being considered to remedy these conditions. It is felt that a study of what has been done in the past would stimulate those interested in the mechanical construction of the instrument and lead to further advances in the future.

The Council feels that the best thanks of the Society are due to the Curator, Mr. W. E. Watson Baker, and to Mr. C. F. Hill in preparing the Catalogue referred to above.

## THE SLIDE CABINET.

Steps have been taken under the direction of the Curator, Mr. E. J. Sheppard, to have a card-index prepared of the Slides in the Society's possession, with a view to rendering them available for the use of

Fellows. A donation has been received from Mrs. J. T. Norman Thomas.

The thanks of the Society are due to Mr. Sheppard for his continued interest and work as Curator.

#### MEETINGS.

The Meetings of the Society have been well attended. The special feature of the present session is a representative series of papers dealing with the "Practical Use of the Microscope in Industrial Research." The papers that have been already read have been of an interesting character, and it is confidently expected that this new policy will considerably increase the influence and Fellowship of the Society, and at the same time be of very great service in the development of British Industries.

The Biological Section, which meets on the first Wednesday in each month, has again had a most successful year.

The Leather Industries Section has held three meetings during the year, and these were of great practical value.

The Metallurgical Section has held two meetings during the year, and has greatly benefited from specimens that have been kindly presented by Dr. J. E. Stead.

The Paper Industries Section, owing to the unfortunate illness of the Honorary Secretary, has not yet held its inaugural meeting, but it is hoped to arrange for the same at an early date.

The thanks of the Council and the Society will be heartily accorded to the Honorary Secretaries of these Sections for the work they have accomplished to make the meetings profitable to those attending.

#### A CONVERSAZIONE

was held at the Mortimer Halls on the 5th October last. It was well attended and the exhibits were greatly appreciated. The thanks of the Society are due to the Fellows of the Society and to the Members of the Quekett Microscopical Club and the Photomicrographic Society, whose assistance contributed to the success of the evening.

#### MARINE BIOLOGICAL ASSOCIATION.

Your Council has contributed the sum of Fifty Guineas to the funds of the Marine Biological Association towards the expenses of an important extension. The R.M.S. table at the Plymouth Laboratory has been placed at the disposal of Mr. E. Channing Matthews, a Fellow of the Society, for the purpose of research work.

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Mr. A. W. Sheppard moved, and Mr. Disney seconded, that the Annual Report be received and adopted. Carried.

**Mr. Cuzner** moved, and **Mr. Bowtell** seconded, that a very hearty vote of thanks be tendered to the Honorary Officers and Members of the Council for their services to the Society during the past year. Carried. **Dr. Murray** responded.

---

The President appointed **Mr. A. W. Sheppard** and **Mr. Ludford** to act as Scrutineers, and afterwards announced the result of the ballot for the election of Officers and Council for the ensuing year as follows :—

*President*.—**Frederic J. Cheshire**, C.B.E., F.Inst.P.

*Vice-Presidents*.—**Arthur Earland** ; **J. W. H. Eyre**, M.D., M.S., F.R.S.Edin. ; **T. H. Hiscott** ; **David J. Scourfield**, F.Z.S.

*Treasurer*.—**Cyril F. Hill**.

*Secretaries*.—**Joseph E. Barnard**, F.Inst.P. ; **James A. Murray**, M.D.

*Ordinary Members of Council*.—**S. C. Akehurst** ; **W. E. Watson Baker** ; **S. H. Browning**, L.R.C.P., M.R.C.S. ; **M. T. Denne**, O.B.E. ; **Aubrey H. Drew**, D.Sc. ; **F. Martin Duncan**, F.R.P.S., F.Z.S. ; **E. Heron-Allen**, F.R.S. ; **R. J. Ludford**, B.Sc., F.R.H.S. ; **Robert Paulson**, F.L.S. ; **E. J. Sheppard** ; **Clarence Tierney**, M.S., D.Sc. ; **Joseph Wilson**.

*Librarian*.—**F. Martin Duncan**, F.R.P.S., F.Z.S.

*Editors*.—**J. W. H. Eyre**, M.D., M.S., F.R.S.Edin. ; **Charles Singer**, M.A., M.D.

*Curator of Instruments*.—**W. E. Watson Baker**.

*Curator of Slides*.—**E. J. Sheppard**.

*Curator of Metallurgical Specimens*.—**F. Ian G. Rawlins**.

A vote of thanks to the Scrutineers was moved from the Chair and carried.

---

**Professor Cheshire** was then installed as President, and thanked the Fellows of the Society for the very great honour they had conferred upon him by electing him to the Presidency of the Society. The primary function of the Society was the national care of the microscope, its design, its construction, its production and its use. The present moment was a very critical one, and there was a very great work for the Society to do. The vital question as to whether British manufacturers should produce microscopes to compete successfully in the world's markets with foreign competitors might be decided in the near future, and the Society ought to have a great deal to do and say in deciding that question.

---

**Professor John Eyre**, M.D., M.S., F.R.S.E., then delivered the Presidential Address, "Microscopy and Oyster Culture."

**Lieut.-Col. Clibborn** moved : "That the best thanks of this meeting be accorded to Professor Eyre for his Presidential Address, and that he be asked to allow it to be printed in the Journal of the Society."

Mr. Taverner seconded the proposal, which was carried by acclamation.

Professor Eyre responded.

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Exhibits were shown by Mr. Ogilvy and Mr. W. E. Watson Baker, who were thanked from the Chair.

---

The proceedings then terminated.

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### AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, W., ON  
WEDNESDAY, FEBRUARY 15, 1922, PROFESSOR F. J. CHESHIRE,  
PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed by the President.

---

The nomination papers were read of nine Candidates for Fellowship.

---

**New Fellows :—**The following were elected Ordinary Fellows of the Society :—

Mr. M. L. Bhatia, M.Sc.  
Mr. Alfred Edward Charlton.  
Mr. William Bernard Crow, M.Sc., F.L.S.  
Mr. William T. P. Cunningham.

---

**Donations** were reported from :—

Mr. Ernest Keevil—  
Miniature Swift Microscope.  
Mrs. Norman Thomas—  
The Norman Thomas Collection of Radiolaria Slides.

A hearty vote of thanks was passed to the donors.

---

**The Deaths** were announced of :—

Mr. Yves Delage. Elected Hon. Fellow 1904.  
Mr. S. A. S. Metheny. Elected 1901.  
Mr. T. W. B. Tomlinson. Elected 1919.

The following papers were read :—

Professor B. L. Bhatia, M.Sc., F.Z.S., F.R.M.S.—

“ Fresh-water Ciliate Protozoa of India.”

Mr. A. L. Booth, A.I.C. (Messrs. Armstrong, Whitworth and Co., Ltd.)—

“ The Microstructure of Coal from an Industrial Standpoint.”

Captain Frank Oppenheimer, I.M.S., M.B., Ch.B., F.R.M.S.—

“ A Portable Microscope.”

A hearty vote of thanks was accorded to the authors of these papers.

---

The proceedings then terminated.

---

## BIOLOGICAL SECTION.

## HONORARY SECRETARY'S REPORT FOR SESSION 1920-21.

I have pleasure in presenting a report on the work of the Section during the past year, for I think you will regard it as satisfactory when compared with that of former Sessions.

During the Session now closed, which was the 13th of the Section, the membership considerably increased in number, the meetings were well attended, and interesting and attractive programmes had been presented. The usual eight meetings on the first Wednesdays in the months November 1920 to June 1921 were held, at which the average attendance was 38·7, which number now forms a record, and compares favourably with 30·1 for the previous year, and with 19·1 for the Session 1915-16, since when the attendance at the meetings has steadily increased.

I may remark here that the attendance would be larger if our meeting-room could accommodate more, for on one occasion (March 2, 1921) 53, including 8 visitors, were present, when the room was packed.

At the first meeting, on November 3, Dr. A. H. Drew gave a practical demonstration of Microscopic Technique, and on December 1 Commander M. A. Ainslie, F.A.R.S., etc., contributed a valuable communication on "*The Correct Microscopic Image.*" At the next meeting, on January 5, 1921, Mr. M. T. Denne, O.B.E., read a paper on "*Monocystis agilis*," and at the meeting held on February 2 Mr. E. Cuzner gave a communication on "*Hydroid Zoophytes.*" The meeting on March 2 was specially devoted to exhibits, when many interesting specimens were shown and described.

On April 6 Mr. E. J. Sheppard exhibited a microtome, and gave a practical demonstration on section-cutting: and on May 4 Mr. H. G. Cannon, B.A., described some experiments on Inheritance in *Simocephalus vetulus*. At our meeting on June 1 Mr. F. Martin Duncan gave a Lecture on "*Studies in Insect Biology.*"

In addition to these communications, which always formed topics for discussion, many beautiful and rare specimens were shown under microscopes and described, thus adding to the interest and usefulness of the meetings.

On December 8 the members visited the Cancer Research Laboratory, Queen Square, on the kind invitation of the Director, Dr. J. A. Murray, who, with his assistants, described the work carried on there and showed many interesting preparations. On June 8, by the special invitation of the President, Professor Eyre, the members visited for the fourth time the Bacteriological Laboratory at Guy's Hospital and inspected many interesting preparations.

The thanks of the members were accorded to Dr. Murray and Professor Eyre for the opportunities given them of seeing the various methods of technique, etc., practised in their laboratories, which were very much appreciated.

J. WILSON.

ANNOTATED LIST OF  
THE METALLURGICAL SPECIMENS  
PRESENTED TO THE ROYAL MICROSCOPICAL SOCIETY  
BY THE CITY OF BIRMINGHAM, 1921.

31. CAST BRASS.—*Mag.* :  $\times 200$ .  
Dendritic structure.  
*Ref.* : “Metallography” (Desch), p 387 *et seq.*
32. STAMPED BRASS.—*Mag.* :  $\times 200$ .  
Structure showing the effect of work.  
*Ref.* : As in No. 31.
33. CAST IRON.—*Mag.* :  $\times 100$ .  
Compare with specimens No. 3 (Hadfield) and No. 24 (Stead).  
*Ref.* : “Metallography” (Sauveur), chaps. xxii. and xxiii.
34. CASE-HARDENED STEEL.—*Mag.* :  $\times 50$ .  
Note the infusion of carbon round the periphery.  
*Refs.* : “Metallography” (Sauveur), chap. xix.  
“The Cementation of Iron and Steel” (Giolitti).
35. HYPO-EUTECTOID ROLLED STEEL PLATE.—*Mag.* :  $\times 200$ . C =  
·42 p.c.  
This specimen shows particularly well the elongation of structure in  
the direction of rolling.  
*Ref.* : “Metallography” (Sauveur), figs. 215 and 216.
36. MILD STEEL BOILER PLATE.—*Mag.* : 200. C = ·15 p.c.  
The structure is similar to No. 35, except for the greater proportion  
of free ferrite, due to lower carbon content.  
*Ref.* : As in No. 35.

F. I. G. R.

THE  
**Royal Microscopical Society.**

Established in 1839. Incorporated by Royal Charter in 1866.

**20 HANOVER SQUARE, LONDON, W.1**

---

**The Society** was established in 1839 for the promotion of Microscopical and Biological Science by the communication, discussion, and publication of observations and discoveries relating to (1) Improvements in the construction and mode of application of the Microscope, and (2) Biological or other subjects of Microscopical Research.

It consists of Ordinary, Honorary, and Ex-officio Fellows of either sex.

**Ordinary Fellows** are elected on a Certificate of Recommendation and signed by three Ordinary Fellows, setting forth the names, residence, and qualifications of the Candidate. The Certificate is read at two General Meetings, the Candidate being balloted for at the second Meeting.

The Admission Fee is 2*l.* 2*s.*, payable at the time of election; and the Annual Subscription is 2*l.* 2*s.*, payable on election, and subsequently in advance on 1st January in each year, but the Annual Subscriptions may be compounded for at any time for 31*l.* 10*s.* The Annual Subscription of Fellows permanently residing abroad is 1*l.* 11*s.* 6*d.*, or a reduction of one-fourth.

**The Council**, in whom the management of the property and affairs of the Society is vested, is elected annually, and is composed of the President, four Vice-Presidents, Treasurer, two Secretaries, and twelve other Ordinary Fellows.

**The Meetings** are held on the third Wednesday in each month from October to June, in the Lecture Hall, at 20 Hanover Square, W.1 (at 7.30 for 8 P.M.). Visitors are admitted on the introduction of Fellows. The business of the Meetings includes the reading of papers, the exhibition of microscopical objects and apparatus, lantern demonstrations, and discussions.

**The Journal** is published quarterly. All Fellows are entitled to a copy, and it is also sold to Non-Members, at an annual Subscription of 42*s.* post free. It contains the Transactions and Proceedings of the Society, and a Summary of Current Researches relating to Zoology and Botany (principally Invertebrata and Cryptogamia), and Microscopy.

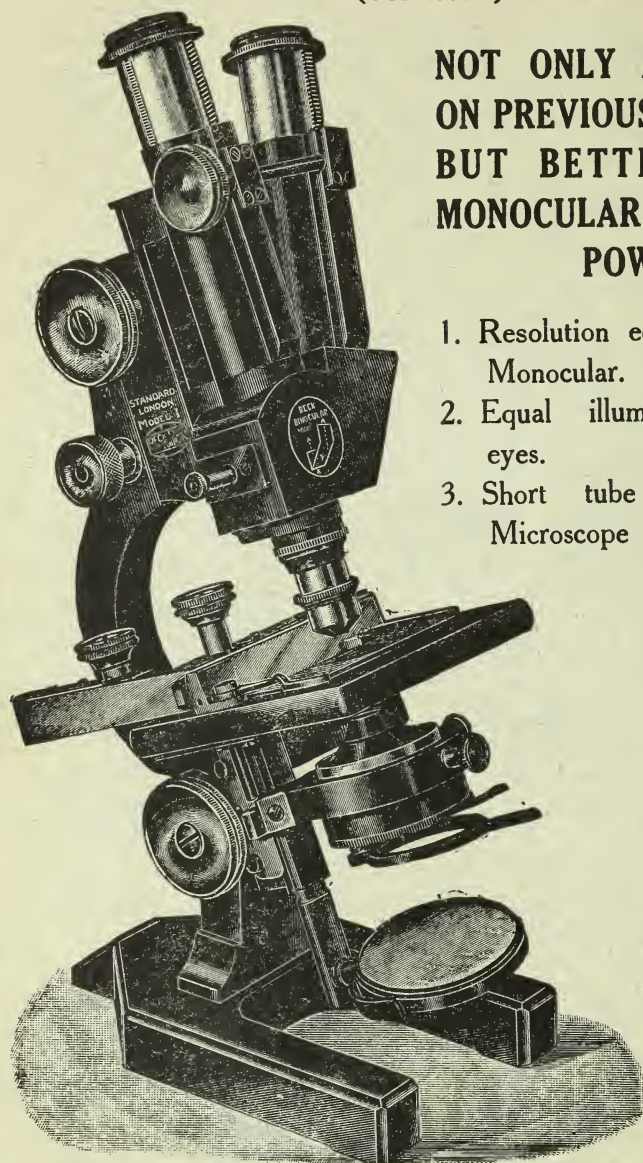
**The Library**, with the Instruments, Apparatus, and Cabinet of Objects, is open for the use of Fellows daily (except Saturdays), from 10 A.M. to 5 P.M. It is closed for four weeks during August and September.

---

*Forms of proposal for Fellowship, and any further information, may be obtained on application to the Secretary, Royal Microscopical Society, 20 Hanover Square, London, W.1*

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# Journal of the Royal Microscopical Society

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS

AND

A SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

MICROSCOPY, &c.

EDITED BY

JOHN W. H. EYRE, M.D. F.R.S. Edin.,

*Professor of Bacteriology in the University of London*

AND

CHARLES SINGER, M.A. D.Litt. F.R.C.P.

*Lecturer in the History of Medicine in the University of London*

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

J. ARTHUR THOMSON, M.A. LL.D.

*Regius Professor of Natural History in the  
University of Aberdeen*

A. N. DISNEY, M.A. B.Sc.

F. IAN G. RAWLINS.

FELLOWS OF THE SOCIETY,

AND

A. B. RENDLE, M.A. D.Sc. F.R.S. F.L.S.

*Keeper, Department of Botany, British Museum*

Minimis partibus, per totum Naturæ campum, certitudo omnis innititur  
quas qui fugit pariter Naturam fugit.—*Linnaeus.*



PUBLISHED BY THE ROYAL MICROSCOPICAL SOCIETY,  
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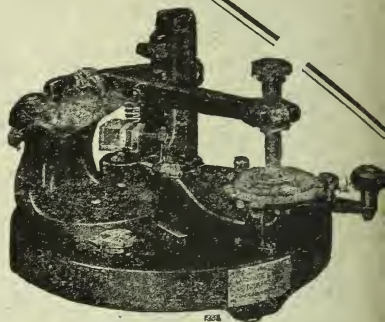
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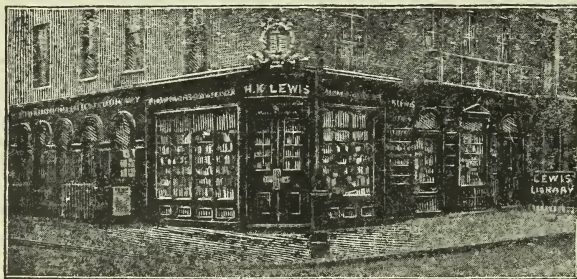
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JUNE, 1922.

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## SPECIAL NOTICES.

**THE ANNUAL CONVERSAZIONE** of the Society will be held at the Examination Hall, 8 Queen Square, Bloomsbury, W.C.1, on Wednesday, 11th October, 1922, from 7.30 to 10.30 p.m. Offers of assistance from Fellows of the Society who can bring exhibits will be greatly appreciated by the Hon. Secretaries.

**COPY OF THE CHARTER** and the **BY-LAWS OF THE SOCIETY**, as revised at the Special General Meeting held on the 21st December, 1921, will be found at the end of this Part.

**THE ROOMS OF THE SOCIETY** will be closed for the Summer Vacation from the 21st August to the 16th September.

**THE TRADE DIRECTORY AND INDEX TO ADVERTISERS** will be found on page 15.

BDH

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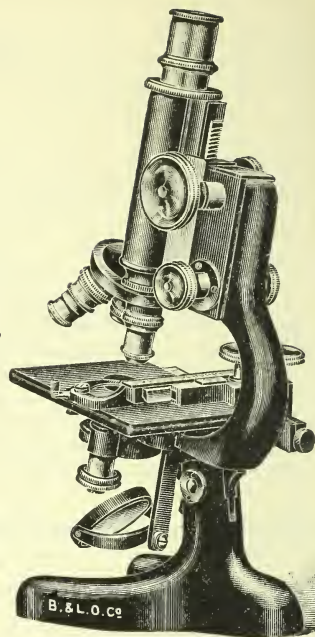
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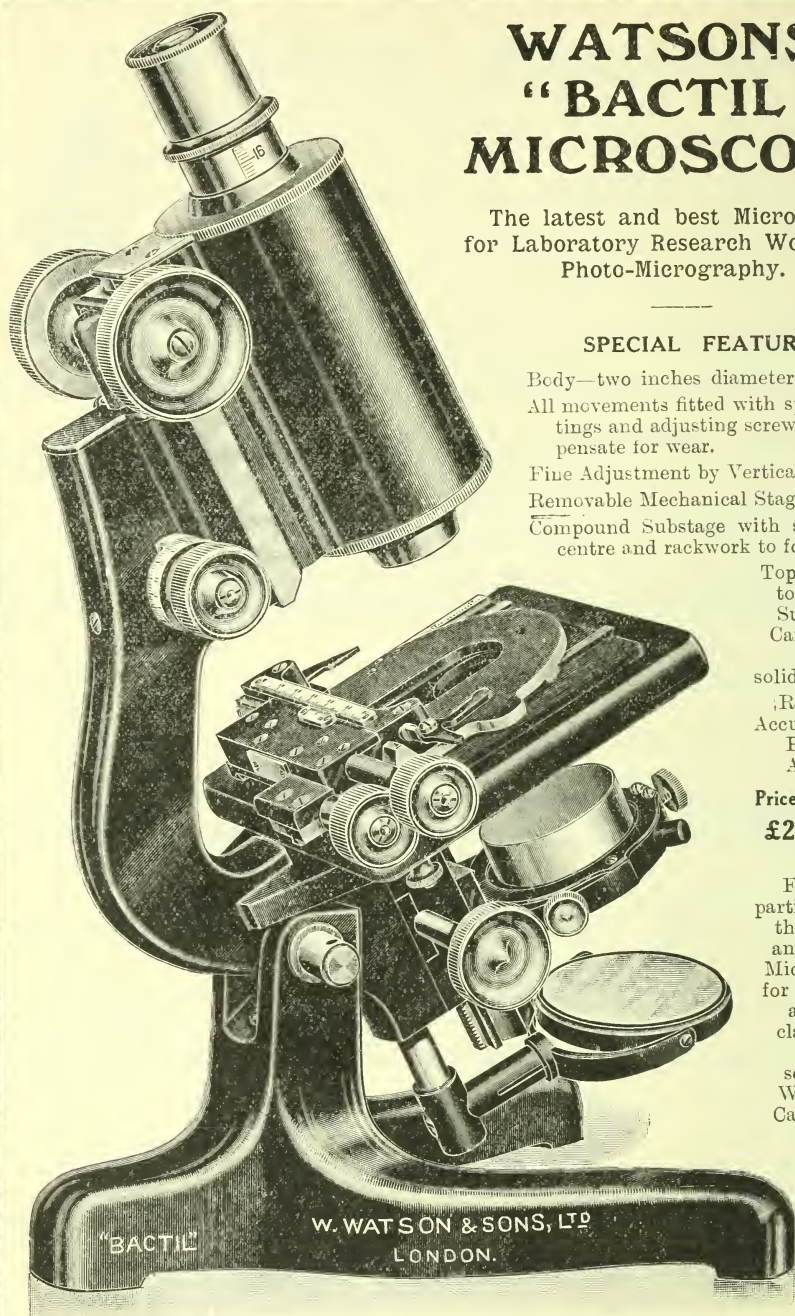
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# JOURNAL OF THE ROYAL MICROSCOPICAL SOCIETY.

JUNE, 1922.

## TRANSACTIONS OF THE SOCIETY.

### V.—THE MORPHOLOGY AND PHYSIOLOGY OF THE NUCLEOLUS.\*

PART I.—*The Nucleolus in the Germ-Cell Cycle  
of the Mollusc Limnæa stagnalis.*

By REGINALD JAMES LUDFORD, Ph.D., B.Sc.(Lond.), F.R.M.S.,  
Dept. of Embryology and Histology,  
University College, London.

(Read April 19, 1922.)

THREE PLATES.

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\* Part of the materials used in this research was purchased by a Government Grant of the Royal Society, for which I express my thanks.

## INTRODUCTION.

SINCE the discovery of the nucleolus in 1781 by Fontana, a great number of papers have appeared dealing with its structure and functions in both animal and plant cells. Besides various peculiarities in behaviour within the nuclear membrane, many observers have described the extrusion of portions of the nucleolus into the cytoplasm during gametogenesis and certain other conditions of metabolism.

There appears to have been much confusion between nucleolar and chromatin extrusions. The description of particles of chromatin being thrown out of the nucleus seemed altogether at variance with the theory of the continuity of the chromosomes throughout the germ-cell cycle; and the fact that the latter theory was so strongly substantiated by cytological studies and breeding experiments led some biologists to doubt whether any "solid" matter was normally extruded from the nucleus into the cytoplasm.

The nucleolus therefore came to be looked upon as an accumulation of waste products of the metabolism of the chromosomes, which was eliminated from the nucleus during cell-division. Recently additional interest has been added to the study of the nucleolus by several important discoveries.

Carleton (5)\* has shown that during cell-division in certain vertebrates, although the nucleolus appears to disintegrate, an argentophile core remains intact and passes in the form of granules into each of the newly-formed nuclei, in which a new nucleolus forms around them. Then both Gatenby and Buchner established the fact that nucleolar extrusions in some insects give rise to secondary nuclei (34), while more recently Gatenby has discovered that in the marine worm, *Saccocirrus*, nucleolar extrusions give rise to the mass of reserve food of the egg (13).

These researches, carried out by the best modern techniques, and in correlation with a study of the cytoplasmic organs, have substantially confirmed the observation of earlier workers, and overcome the criticism of those who had maintained that the nucleolus is nothing more than the accumulated waste products of the nucleus.

The present paper is the outcome of an earlier one published in this Journal (34). In working out the behaviour of the cytoplasmic organs during the oögenesis of *Patella*, a complicated case of nucleolar behaviour was met with. The nucleolus was seen to extrude fragments of an oxyphil staining substance throughout oögenesis. Lack of suitable material prevented the behaviour of the nucleolus being followed beyond maturation, so that at the suggestion of Professor J. Brontë Gatenby, of Dublin University, I carried out this investigation on the aquatic Mollusc, *Limnaea*; and in the present paper is described for the first time the behaviour of the nucleolus throughout the life cycle of an organism.

\* The figures in brackets refer to the bibliography at the end of the paper.

The early part of the research was carried out in Professor J. P. Hill's laboratory, at University College, London. My thanks are due to him for the facilities there offered, and for his interest in the work. I have also to thank Professor J. Brontë Gatenby for kindly reading through the completed manuscript.

To Dr. J. A. Murray, Director of the Imperial Cancer Research Fund, I am indebted, for examining some of my material and assisting me with his advice.

#### PREVIOUS WORK.

1. "*Solid*" *Extrusions from the Nucleus during Gametogenesis and Development.*—The nature of the relationship existing between the nucleus and the cytoplasm is one of the fundamental problems of cytology. Certain writers hold the opinion that the nucleus controls and directs the activities of the cytoplasm by the extrusion of small particles of chromatin into it; such chromatin bodies they term "chromidia." Schaxel (50) ascribes to them an all-important rôle in the conversion of the undifferentiated embryonic cells into the specialized cells of the somatic tissues. According to this writer, in the early stages of the development of the fertilized ovum, there is no extrusion of solid substance from the nucleus, but this process occurs as soon as differentiation and specialization of the cells commence. These conclusions are open to a considerable amount of criticism, as other investigators working upon the cytoplasmic organs in development, notably Duesberg (10) and Gatenby (11), have observed bodies similar to the chromidia of Schaxel, which they have found to be mitochondria. It is therefore extremely doubtful whether there are such bodies as the "chromidia" of Schaxel, which function in the way he describes.

There does, however, appear to be an extrusion of "solid" matter from the nucleus of Protozoa (9), but whether the extruded substance is chromatin, is difficult to say. Hertwig (25) describes in *Actinospherium* an excessive enlargement of the nucleus in comparison with the cytoplasm, under certain conditions of growth, which is followed by the extrusion of what he calls chromatin into the cytoplasm, where it becomes converted into a brown pigment. As I have pointed out in a previous paper (34), it is practically impossible on staining tests alone to distinguish chromatin, and the extruded nuclear substance may possibly be nucleolar in origin. The nature and function of the nucleolus, however, is quite unknown, so that it is desirable to bear in mind in this connexion that certain observers look upon the nucleolus as the centre for the accumulation of chromatin, preparatory to its extrusion from the nucleus (2).

During gametogenesis, numerous cases of extrusions from the

nucleus into the cytoplasm have been described; much of the recent literature I have already reviewed in a previous paper (34). There seems every probability that the so-called "chromidia," emitted from the nucleus of germ cells at the bouquet stage, as described by writers such as Buchner and Jorgensen, are really the cytoplasmic organs—Golgi apparatus and mitochondria—which are usually found at that stage in the position where these writers figure chromidia.

Several cases have been described recently of fragments of the nucleolus passing, during oögenesis, through the nuclear membrane into the cytoplasm, and either dissolving there or else giving rise to yolk bodies (34). A somewhat similar process is mentioned by Wassilieff (61) in the spermatocyte of *Blatta*, but whether the structures there described are really nucleolar or chromatin extrusion, or are cytoplasmic organs is open to doubt.

It is of interest to note that in the cases of oögenesis recently described, the solid substance thrown out from the nucleus into the cytoplasm is derived from the nucleolus, and is not regarded as interfering in any way with the integral continuity of the chromosomes throughout the germ-cell cycle. Further, the extrusion appears to be related to yolk formation rather than having any special formative effect. It is of course impossible to say whether there are any other effects upon the growing oöcyte.

There are, however, certain cases of substances extruded from the nucleus, which exert a definite after-effect. The so-called "anello cromatico" of Giardina is a case in point (16). Giardina found in the oögonium of the beetle *Dytiscus* that the nucleus became differentiated into two parts, the one containing irregular granules of chromatin which represent the chromosomes, the other of an irregular-shaped mass—the "anello cromatico." Such an oögonium divides repeatedly. Each time while the chromosomes are undergoing either meiosis or mitosis, the "anello cromatico" remains at one side of the cell and passes in its entirety into one of the newly-formed cells, so that ultimately only one of the sixteen cells into which the oögonium divides contains this structure. This cell alone becomes the oöcyte, the others give rise to nurse cells. The "anello cromatico" appears to be composed of plastin, and to be of a nature similar to the nucleolus. Later in the development of the oöcyte it breaks up, and long before maturity is reached it has disappeared altogether from the oöcyte.

Several cases have been described of the nucleolus functioning as a germ-cell determinant. Silvestri (53), quoted by Hegner (23), studied the development of the ova in both monembryonic and polyembryonic hymenopterous parasites. He found in each case a germ-cell determinant which he termed the "nucleolo," and he considers it to be derived from the plasmosome of the oöcyte

nucleus. This has been disputed by Gatenby (14), and is not now generally believed. When the fertilized egg nucleus divides in embryogeny, the "nucleolo" is situated at the lower pole of the egg. Later it breaks up and certain cells come to contain portions of it. These cells, which are situated at the lower pole of the egg, give rise to the germ cells of the embryo.

A somewhat similar germ-cell determinant has been described by Haecker in a medusa, *Aequorea forskalea* (20). About half an hour after its egg has been discharged, the nucleolus disappears from the nucleus, and a similar body appears in the cytoplasm. Haecker believes the latter to be the extruded nucleolus and terms it the "metanucleus." It persists until the sixty-four cell stage, passing intact at each cell division into one cell. It is suggested that this cell would give rise to the germ cells.

Haecker considers the cytoplasmic structures described in eggs by several other observers (4, 6, 24) to be of a similar nature; probably in these cases also there has been confusion with the cytoplasmic organs.

In *Myxostoma*, Wheeler (63) describes the nucleolus of the oöcyte as remaining in the cytoplasm and persisting as a distinct body in one of the large posterior macromeres at the eight-cell stage. Such a macromere is said to give rise to the endoderm.

In opposition to these views it should be noted that Gatenby, who investigated by the best modern cytological methods, the nature of the germ-cell determinant in *Apanteles* (14), found that it originated in the cytoplasm and that neither the cytoplasmic organs nor nucleolar, or chromatic emissions from the nucleus, were directly concerned in its formation.

2. *The Nucleolus in Somatic Cells.*—The term nucleolus is applied in the present paper to the so-called "true nucleolus," or plasmosome. It is usually considered to be a pyrenin body, containing less phosphorus and more albumen than the chromatin. In general it stains with acid stains, while the chromatin takes up basic stains. That this is not universally true, has been pointed out in previous papers (13, 34).

The number of nucleoli occurring in cells varies considerably. From one to five is the most usual number, but several hundreds may be present, as in the subcuticular gland cells of *Piscicola*. Although in most cells a nucleolus is present throughout their life, yet in some it develops only in the course of the activities of the cells; the mesenchyme cells of *Cerebratulus* are an example of this (42).

Balbani in 1864 (3) first described movements of the nucleolus in living cells, and since that time similar activities have been described by many writers for all types of cells, both plant and animal. Balbani described the formation of vacuoles in the nucleolus which he said were discharged through a small orifice.

More recent workers on tissue cultures have pointed out that the nucleolus is in a constant state of movement. Macklin (38), observing cells of the embryo chick, says that "the nucleoli of the connective tissue type of cell are irregular in shape, often elongated, and vary greatly in size. In the living cell they are highly refractive. They continuously undergo changes in shape, size and number during the life of the cell. Their outline is jagged, and they appear to break up from time to time, and afterwards recombine. At times the nucleolus comes to be very close to the nuclear membrane, and it may even appear to be attached to it. It is probably to be regarded as a gel of varying density, the densest portion being represented by certain densely staining granules." In nucleoli of plant cells, crystals have been described by several observers (48).

The problem of the relation of the nucleolus to the other nuclear organs raises considerable difficulties. Montgomery (42) considers that it is merely held tightly in the nuclear network like "a ball lodged in the branches of a tree, its movements hindered by the intervening branches, but not immovable." He considers that it has an extranuclear origin. His conclusions are derived from a study of the ova of Nemerteans and the mesenchyme cells of *Cerebratulus*, in which he states that "the nucleolus appears to assimilate a substance or substances from the cytoplasm, and after this substance has entered the nucleus it apparently undergoes there a chemical change, and becomes deposited on the inner surface of the nuclear membrane in the form of masses of varying dimensions." Opposed to this view, are the greater number of observers, who regard the nucleolus as arising in some way from nuclear elements.

There is considerable variation in the behaviour of the nucleolus during cell division (35). In some cases of amitotic division the nucleolus is seen to divide preparatory to the division of the nucleus as a whole, but this mode of behaviour is not general, as often there is no initial nuclear division at all.

Macklin, from observations on living cells (38), concludes that "the nucleolus has no direct relationship to nuclear division during amitosis. It may, however, have to do with the size of the nuclear portions; when these latter are equal they each contain one or two nucleoli of about equal size, whereas when they are unequal one portion, usually the smaller, may not contain a nucleolus." Mitosis has been observed after amitosis, preparatory to which, the nuclei separated amitotically, fuse, and from this fused mass the chromosomes are built up. It is instructive to compare with this type of behaviour the part played by the nucleolus during nuclear fragmentation—a pathological process, occurring in the presence of toxins, or in the absence of an adequate supply of oxygen. The nucleus before fragmentation is irregular in outline

and multilobulated. It breaks up into a number of unequal parts, which do not as a rule contain nucleoli. Nuclear fragmentation is not followed by mitosis, as it appears to be a degenerative process.

During mitosis, the nucleolus may be cast out into the cytoplasm, where it persists for a time—Gjurasin (17), Karsten (31)—or it may divide and the pieces pass into each daughter nucleus, as described by Schaudinn (49) in *Amoeba crystalligera*, by Winge (64) in the slime fungus *Sorodiscus*, and by Keuten (32) in *Euglena*. More often preparatory to the formation of the chromosomes, the nucleolus disintegrates and disappears. The persistence of an argentophile core in such cases, described by Carleton (5), has already been referred to, but persistence of the nucleolus as a whole, during mitosis, is atypical. The process of dissolution of the nucleolus preparatory to chromosome formation, raises the very difficult problem as to whether there is any functional relationship existing between nucleolus and chromosomes. At all events, when such stains as methyl-blue eosin are used, the newly constituted chromosomes now stain with eosin. Montgomery (42) says of this peculiarity that it "may be explained either by the assumption that the whole or part of the nucleolar substance unites chemically with the chromatin, or that it simply penetrates into the meshes of the latter." It does not, however, "appear so to unite chemically, and therefore the chromatin does not carry it over into the daughter cells."

The whole matter is very difficult to understand, and there is considerable divergence of opinion on the part of those who have specially studied this problem.

3. *Nucleolar Extrusions in Somatic Cells.*—The extrusion of portions of the nucleolus during oögenesis has been described by a great number of writers, and this aspect of nucleolar behaviour has been discussed by me in a previous paper (34). Examples of extrusions in somatic cells are more rare, but several cases have been described within recent years. Montgomery (42), who made an extensive survey of the literature on the nucleolus up to 1898, refers especially to the work of Lukjanow (36), who described nucleolar extrusions in the stomach mucosa of *Salamandra*, and Humphrey (28), who observed the same phenomenon in plant cells. Of interest, also, is his account of the observations of Steinhaus (54), who from a study of the intestinal cells of *Salamandra* concluded that there was a plasmosome extrusion in these cells, and that the extruded plasmosome substance increased in size by imbibition, and combined with karyosomes to form a new nucleus. Such a process recalls to mind the formation of secondary nuclei in insects to which reference has already been made.

One of the most remarkable cases of nucleolar extrusion is that described by Montgomery (42), in the subcuticular gland

cells of the worm, *Piscicola*. In these cells a very large number of nucleoli are developed. Then at the time when the cell begins its secretive activity by the formation of granules in the cytoplasm, the nucleus, which up till now has been much lobulated, becomes rounded and contracts. The result is that the nucleolar fragments become shot out into the cytoplasm, where they form a kind of reticulum which persists for some time. Later it disappears, its ultimate fate being unknown.

Extrusions of nucleolar fragments from "resting cells" have been described by Walker and Tozer (59) in quite a number of animals, and some plants. They found this process occurred in *Spongilla*, *Planaria lactea*, *Polycelis nigra*, leucocytes from the small intestine and cells from both the small and large intestines of the rabbit, and in cells of the leech (*Clepsine*), in endoderm cell of *Hydra fusca*, and in the root tip of the bean. An earlier paper by Walker and Embleton (58) was devoted to an account of the process in the endoderm cells of *Hydra*. They noted that while the extrusion of nucleoli in the endoderm cells was very common, in the ectoderm cells it was remarkably rare. As the endoderm cells are actively engaged in digestion, the conclusion was drawn that the process was related to digestion. In both of these papers the writers emphasize the fact that the nucleolar substance which has been thrown out into the cytoplasm undergoes a change in staining reaction. Walker and Tozer conclude that the phenomena of nucleolar extrusion "occurs in somatic cells of both animals and plants very generally, particularly in those cells where active metabolism takes place, and multiplication does not occur to any great extent, or is practically absent in the adult organism." The process is interpreted "as being directly connected with nuclear metabolism, and the migrating nucleoli are looked upon as the bearers of excretory and secretory products from the nucleus to the cytoplasm." This may be the means by which the nucleus discharges material when the cell is in the vegetative condition.

In the nerve cells of mammals, Page May and Walker (40) have described another type of nucleolar behaviour. Their material consisted of the cells from the Gasserian and cerebrospinal ganglia of rats, rabbits, cats and monkeys. The nucleoli in these cells increased in number by budding or fission; then particles were extruded from the nucleus, and these, after undergoing a change of staining reaction, were in some cases discharged completely from the nerve cell into the cytoplasm of a leucocyte or of a capsular cell.

Another worker who has described nucleolar extrusion is Nakahara. He has observed the process in the adipose cells and in the silk-gland cells of certain insects. In the former case he believes that the extruded nucleolar fragments become metamorphosed

into albuminous granules (45); while in the silk-gland cells "as the nucleoli migrate from the nucleus they seem to give off phosphorus to form themselves one of the lowest members of the nuclein series" (44). He concludes that "this statement on the chemical change may hold true for the migrating nucleoli in different other cells."

According to Adami (1) nucleolar extrusions are quite common in pathological conditions of cells. In "cloudy swelling," a condition of cell intoxication accompanying acute fevers, the extrusion of nucleolar matter into the cytoplasm is followed by the appearance of albuminous granules in the cytoplasm. This condition is well seen in the liver cells with phosphorus poisoning. Adami states that "the indications are that the higher syntheses, those associated with growth and those governing the specific enzyme actions of the different forms of cells, are determined and initiated by the nuclear matter." He suggests that this process is carried out through the intermediation of nucleolar extrusions.

4. *Cytomyxis*.—A phenomenon in some ways similar to that described as occurring in the nerve cells of Mammals, is that to which Ruggles Gates (15) has given the name *cytomyxis*. During pollen formation in certain plants "a portion of the chromatin of one pollen mother-cell passes through an opening in the cell-wall into the cytoplasm of an adjacent mother-cell." This occurrence has been said to be pathological or an artifact due to fixation, but Ruggles Gates observes that "in some cases it is followed by a return of the nucleus (from which the extrusion has taken place) to a central position in the pollen mother-cell, and absorption of the extruded chromatin in the cytoplasm of the invaded cell."

The extruded nuclear substance forms what Gates calls a "pseudo-nucleus"; it persists for a time in the invaded cell, and eventually breaks down and disintegrates.

5. *Experimental Researches on the Nucleolus*.—Very little experimental work has been carried out on the nucleolus, but the few papers which have appeared on this aspect of the subject show that we have here a very fruitful field for further research.

Wace Carlier (65) investigated the behaviour of the nucleolus in the oxyntic cells of certain mammals during the secretion of the gastric juice. He found that after the application of a stimulus—in this case the smell of food—both the nucleus and nucleolus increase in size. With continued activity the nucleus as a whole shrinks considerably, but the nucleolar matter increases in amount, and fragments of it are expelled into the cytoplasm, where they remain for a time, then disintegrate. As the cell begins to recover from the "exhausted condition," the nucleus grows larger again, as does the nucleolus, and when the nucleolar matter becomes excessive, extrusion occurs once more either by the expulsion of the entire nucleolus or fragments of it.

According to Carlier this process is seen most clearly in the cells of the stomach glands, but it occurs also in cells of the glands lining the alimentary canal, in salivary glands, and in the liver.

In connexion with these observations, it is interesting to note that similar cases of nucleolar extrusions have been described by Maximow (1) in the salivary glands, and by Macallum (48) in the pancreas, in both of which cases, the extruded plasmosome material is believed to be related to the formation of secretory products in the cells.

Wace Carlier regards the nucleolus as "effete material, derived in some way from the chromatin during nuclear activity, and from the nutrient material taken up by the exhausted nucleus during the synthesis of chromatin from it. This effete material being no longer available for nuclear activity, and when abundant tending to interfere with the proper performance of nuclear functions, is removed from the nucleus, either bodily, or after fragmentation, and passes into the cytoplasm, in which it ultimately disappears. It is not denied that the extruded nucleolar substance may subserve some useful purpose, "but so far as the nucleus itself is concerned it is useless and effete, and may even prove a source of danger if too long retained."

Gustav Mann, who also carried out physiological researches on the nucleus, held the view that "the nuclear chromatin was the organ for the transformation of simple into more complex compounds," while the "nucleolus is a storehouse for material which has been elaborated by the nuclear segments" (39). Huie (27), one of Mann's pupils, carried out a series of experiments on the nucleus in the insectivorous plant *Drosera rotundifolia*. When the gland cells were stimulated by feeding on albumen, the basophil substance in the ground cytoplasm became used up and was replaced by oxyphil-staining plasma. "The restoration of the cytoplasm was brought about by the nucleus absorbing food material, metabolizing it, and then excreting it into the cytoplasm." Preceding the restoration of the cytoplasm, the basophil nuclear substance, which had become considerably diminished as the result of the secretory activity, increased in amount; the nucleolus however was very small. When, however, the cytoplasm was restored to its "resting" condition, the chromatin was reduced in amount, but the nucleolus was increased.

By the administration of antipyretics, nuclear oxidative processes are greatly retarded; the result in *Drosera* was to postpone the increase of nuclear chromatin which occurs after feeding with peptone for from five minutes to thirty hours.

These results are advanced as evidence in support of Mann's theory of the metabolic functions of the nuclear organs.

6. *Theories as to the Function of the Nucleolus.*—Before concluding this survey of the literature of the nucleolus, a short

summary of the various theories as to its function will serve to show that we are still far from having reached any satisfactory conclusion as to its real significance in the cell; and that it remains to-day one of the cell organs of whose rôle in vital activities we have the least definite knowledge.

The various theories that have been advanced may be classified in groups as follows:—

(i.) *Waste Product Theories.*—Watasé (62) held the view that the nucleolus merely represented the accumulated waste products of the nucleus, and this view has been maintained by many other workers. Wace Carlier considered that it was necessary for such waste material to be cast out of the nucleus into the cytoplasm, where it might serve some useful purpose. Haecker considered the nucleolus to be a pulsating excretory organ with contractile vacuoles for expulsion of effete material.

(ii.) *Nutrition Theories.*—Derschau (48) looks upon the nucleolus as the centre of the vital activities of the cell, and fragments of the nucleolus, he says, carry chromatin out to those regions of the cytoplasm where it is required for formative processes. This is the most extreme expression of this group of theories.

Korschelt held that the nucleolus represented a nuclear secretion discharged into the cytoplasm during cell division. Montgomery (42) considered that it had an extranuclear origin, and that "it stands in intimate connexion with the phenomena of nutrition of the nucleus." Sharp (48) holds a similar view as to its relation to nuclear metabolism.

Julin (30) also thought that the nucleolus conducted the vegetal processes of the cell; and Walker and Tozer (59) expressed similar views, regarding the nucleolus as bearing, in the form of migratory particles, excretory and secretory substances from the nucleus into the cytoplasm.

Nakahara (46) in a recent paper has reconciled the two opposing views as to the intra and extra nuclear origin of the nucleolus. He writes, "Different views concerning the nucleoli, and especially the question of their origin, can be brought into harmony under the hypothesis that the nucleoli represent substances going through the nucleus in metabolism. According to this hypothesis, nucleoli may be formed directly of a material taken up by the nucleus, or may be produced from some substances within the nucleus in the course of metabolic processes."

(iii.) *Binuclear Theories.*—The theory that the nucleus contains two kinds of chromatin has been put forward by Schaudinn, but most ardently advocated by Goldschmidt, who wrote, "Every animal cell is by nature binucleate; it contains a somatic and propagatory nucleus. The former (kinoplasm) presides over somatic functions, metabolism and movement. The propagatory

nucleus (idioplasm) contains especially the hereditary substances, which also possess the ability to generate a new somatic nucleus. In tissue-cells the separation may be quite unnoticeable" (9).

Various writers have sought to identify the chromosomes with the idioplasm, and the nucleolus with the kinoplasm.

A certain amount of evidence has been accumulated in support of this view, and the nucleolus does appear to be related to nutrition; but Dobell, who has written a review and summary of the theory, concludes that we "require many, many more facts and unbiassed observations before we can hope to unravel the tangled skein" of which this problem is but a part.

In a recent paper in "Science Progress," 1921, Gatenby has brought forward the view that the nucleolus represents not the kinoplasm but the trophoplasm or trophochromatin.

(iv.) *Germ-Cell Determinants*.—Both Silvestri (53) and Haecker (20) have suggested, probably erroneously, that the nucleolus may function as a germ-cell determinant. Very little work, however, has been carried out on this aspect of the subject, and there is great need for more information before drawing conclusions.

(v.) *Chromatin Theories*.—There has been a considerable amount of discussion as to the relation of the nucleolus to the chromosomes. Strasburger (56) believed that in the somatic nuclei of many plant cells most of the chromatinic substance was stored in the nucleolus, while Schaxel (50) held the same view with regard to the nucleolus of the oöcyte of *Echinus*. It is generally agreed now that the nuclear network gives rise to all the chromosomes. In this connexion Sharp (48) writes, "Although the nucleolus furnishes no morphological element, chromatic material may flow from it to the chromosomes as they develop from the reticulum." He cites as evidence the work of Strasburger and Berghs (48) on *Marsilia*.

I have suggested elsewhere that the basophil nucleolus found in the oöcytes of Molluscs may be related to the contraction of the large nuclear reticulum to form the chromosomes. According to Sharp, Eisen does not consider the nucleolus has anything to do with the chromosomes in so far as their idioplasmic constitution is concerned, but he regards the nucleolar material as a reserve constituent of the linin reticulum. Schürhoff (52), on the other hand, regards it as a reserve constituent of the chromatin.

(vi.) *Cell-Division Theories*.—The observations of Remak and others upon the behaviour of the nucleolus during amitotic nuclear division, led to the conclusion that this organ played an important part in cell division. In certain cases of amitosis, the nucleolus divides previously to nuclear division. From this it was assumed by some workers that the nucleolus actually initiated the division of the nucleus. Since however this type of cell division was first described, it has been found to be extremely rare, and in some

cases where amitosis has been observed in living cells, it has not generally taken place according to Remak's scheme.

Other theories of nucleolar function have attributed to this organ, functions in connexion with the achromatic structures which play such an important part during karyokinesis. One of the most important of these theories is that of Strasburger (55), who suggested that the nucleolus in certain plants was a mass of reserve kinoplasm which indirectly formed the achromatic figure.

The above outline of theories of the function of the nucleolus is not intended in any way to be inclusive, but is given in order to show the diverse views that have been entertained by those who have worked on the subject. Probably the nucleolus does not serve the same purpose in all cells, or may be it performs normally a variety of functions, so that there may be a certain element of truth even in the most divergent opinions that have been held as to its function.

#### PRELIMINARY INVESTIGATIONS WITH FRESH-WATER MOLLUSCS.

At the commencement of this investigation several different species of our common fresh-water molluscs were collected and kept in aquaria.

In the early summer when ovulation had commenced, gonads were dissected out from a specimen of each species, and preparations were made from them and examined microscopically. The extrusion of plasmosome substance from the nucleus into the cytoplasm was observed in *Planorbis* and in *Limnæa stagnalis* and *L. auricularia*, which were specially studied. Of these species *L. stagnalis* seemed to be the most suitable for detailed study, first because the eggs were found to be the easiest to manipulate, and secondly because yolk formation in the oöcyte and the behaviour of the Golgi apparatus and mitochondria during embryogeny have already been worked out by Gatenby (11).

#### ONTOGENY OF *LIMNÆA STAGNALIS*.

*Limnæa stagnalis* is one of our commonest aquatic pulmonate molluscs, the size it attains being determined within limits by the size of the pond in which it lives, the biggest specimens occupying the largest ponds. It is hermaphrodite, and within its gonads both male and female germ cells are to be found in all stages of development.

Apparently it is self sterile, the eggs of one individual only being fertilized by the sperms of another.

During the late spring and early summer, numerous eggs are laid in the form of clusters, their number varying from about fifteen to over a hundred. Fertilization occurs after laying. Each

egg is surrounded by a membrane, inside of which is a semi-gelatinous fluid, and the whole of the eggs are contained within a gelatinous envelope, rendering it extremely difficult to fix such material. Cleavage and differentiation of the ovum takes place inside the gelatinous capsules, and the young mollusc does not launch out into the world until well advanced in development.

#### TECHNIQUE.

The behaviour of the nucleolus during oögenesis and spermatogenesis was studied in preparations made from gonads fixed in Bouin's picro-formal-acetic, corrosive acetic or alcohol acetic. The stains used included eosin and hæmatoxylin, iron alum hæmatoxylin, Auerbach's and Pappenheimer's stains, Obst's carmine and methyl green, and Mann's methyl-blue eosin. The best preparations were obtained with corrosive acetic fixation and Mann's methyl blue eosin.

The preparation of the ova and developing embryos presented problems of considerable difficulty, owing to the impenetrability of the gelatinous membranes in which they are enclosed.

Attempts were first made unsuccessfully to fix the egg masses entire in picro-formal-acetic and corrosive acetic. Then the outer gelatinous envelope of each egg mass was cut open, and the eggs were scraped out with a knife blade on to filter paper, which removed the adhering mucilage of the envelope. The eggs surrounded by the outer membrane and inner semi-gelatinous fluid were then transferred to various fixatives for varying periods of time. The fixatives tried were Bouin, corrosive acetic, Carnoy, Gilson, Petrunkevitch, and a mixture of the two latter. In all cases the eggs failed to clear when transferred to either chloroform or xylol after passage through the alcohols.

In these earlier attempts the trouble in fixation arose owing to the difficulty in getting the fixative to penetrate the peripheral layer of mucilage around each egg. Various methods were tried for tearing open this surrounding layer of semi-gelatinous substance. Under a simple microscope, eggs which had been removed from the outer envelope of the egg cluster were stabbed with fine forceps and immediately dropped into the fixative. This method was hardly successful, as the eggs in most cases came completely away from their surrounding membrane, and owing to their extremely small size it was most difficult to manipulate large numbers in this condition.

It seemed best after a large number of preliminary experiments to prick an opening in the membrane enclosing the semi-gelatinous fluid around each egg—an opening sufficiently large to allow the fixative to penetrate freely, but not large enough to allow the egg to float out. At first eggs were pricked with fine steel needles to

which they adhered, and they were then plunged into either Bouin or corrosive acetic. Steel needles were unsatisfactory for this purpose, as the eggs tended to stick to their surface and then immersion in the fixing solution caused corrosion.

Ultimately, very finely drawn out threads of glass were utilized with most excellent results.

The method I therefore adopted for the preparation of the eggs and embryos was as follows:—The egg clusters were removed from the aquaria and laid on filter paper. Each cluster was cut in halves with a fine pair of scissors. With a small knife blade the eggs were then scraped out on to filter paper and rolled about so as to get rid of the adhering mucilage from the outer envelope. The filter paper was then moistened and placed in position under a simple microscope. Each egg was then manipulated with two glass rods made by drawing out rods of glass of small diameter in a flame. With a curved rod each egg was rolled over and over until it no longer adhered to the moist filter paper but moved quite freely. It was then stabbed with a finely pointed glass piercer, to which it adhered. The piercer was then dipped into the fixative, when the eggs immediately slid off. The fixative was contained in a small glass tube about  $\frac{3}{4}$  in. in diameter and 1 in. in height. After fixation the various alcohols were transferred to the material while still in the same tube, the liquids being drawn off by pipettes. Finally, the embedding in wax was completed in the same vessel, and when the wax hardened, the tube was carefully broken open and the solid wax block removed and serial sections cut in the usual manner.

The fixation which gave the best results was corrosive acetic, 1·5 p.c. acetic acid and 98·5 p.c. saturated solution of corrosive sublimate, for about three or four hours.

This method has the great advantage of enabling large numbers of eggs and embryos to be dealt with at the same time, and the process can be performed quite expeditiously.

#### THE BEHAVIOUR OF THE GOLGI APPARATUS AND MITOCHONDRIA DURING GAMETOGENESIS AND EMBRYOGENY.

Observations on the extrusion of solid substances from the nucleus into the cytoplasm recorded previously to the discovery of cytoplasmic organs have been open to criticism, on the grounds that there has been confusion between these organs and chromidia or nucleolar extrusions.

Mitochondria and Golgi apparatus, as is well known, are preserved by fixatives which contain certain chrome salts and osmic acid, but destroyed by acetic acid. In some cases, however, when both osmic acid and acetic acid in small proportions are present, the mitochondria may remain badly preserved in the

## EXPLANATION OF PLATE SHOWING THE BEHAVIOUR OF THE NUCLEOLUS IN THE LIFE-HISTORY OF LIMNÆA STAGNALIS.

*Lettering.*—A, aster introduced into ovum by the sperm; B, remains of basophil portion of the nucleolus; BC, binucleate cell; BP, basophil staining part of the nucleolus; BV, nuclear vacuole staining faintly basophil; C, nucleus of connective tissue cell of the trabecular wall of the ovatestis; CF<sub>1</sub>, CF<sub>2</sub>, cells which have recently undergone mitosis; CH, chromosomes; CL, cilia; CP, cell at prophase stage of mitosis; CR, masses of basophil staining substance in the nucleus, presumably chromatin; CT, cell at telophase stage of mitosis; DN, dividing nucleolus; ED, endodermal cell; ET, ectodermal cell; FB, fragment of basophil staining substance derived from basophil part of nucleolus; FO, fragment of oxyphil staining substance derived from oxyphil part of nucleolus; FP, female pronucleus; GA, element of Golgi apparatus; GE, cell of germinal epithelium; H, head of spermatozoon; M, mitochondria; ME, mesodermal cell; N, nuclear membrane; NC, sertoli or nurse cell; NE, nucleolar extrusion into cytoplasm; NL, nucleolus (oxyphil staining body or plasmosome); NP, pseudopodia-like process of the nucleolus; NR, denser peripheral layer of nucleolus; NV, vacuoles inside the nucleolus; NX, substance probably of the nature of a nucleolar extrusion; NY, nucleolus disintegrating during formation of chromosomes; OC, oöcyte; OP, oxyphil staining part of nucleolus; OV, nuclear vacuole staining faintly oxyphil; P<sub>1</sub>, first polar body; P<sub>2</sub>, second polar body; PN, nucleus of polar body; PR, filament of protoplasm connecting developing head of spermatozoon with nurse cell; R, nuclear reticulum; SE, division spindle; SG, granules formed as the result of secretory activities of the cell; SN, male pronucleus; SP, developing head of spermatozoon; T, trabecular wall of ovatestis; TL, tail of spermatozoon; V, vacuole in cytoplasm; Y, yolk granule.

The oxyphil staining nucleolus (NL), and the substances extruded from it into the cytoplasm are shown in red, as are also certain granules which appear to be of the nature of nucleolar extrusions. These latter granules stain almost exactly similar to yolk granules, which renders accurate observations extremely difficult.

The sperm heads at those stages of development when they stain oxyphil are also shown coloured red.

All the figures are drawn from portions of the ova-testis fixed in corrosive acetic and stained with either Mann's methyl blue eosin, or carmine and methyl green after the method of Obst.

## EXPLANATION OF PLATE III.

*Fig. 1.*—Cells of the germinal epithelium (GE), attached to the trabecular wall (T), of the ovatestis.

*Fig. 2.*—Young oöcyte attached to the wall (T) of the ovatestis, showing the large oxyphil nucleolus (NL) and nucleolar substance (NE) passing out into the cytoplasm.

*Fig. 3.*—Oöcyte with nucleolus differentiated into oxyphil (OP), and basophil (BP) staining portions. Nucleolar extrusion occurring at NE. Cytoplasm filled with yolk granules.

*Fig. 4.*—Nucleus of an oöcyte showing the extrusion of oxyphil substance (NE) and the disintegration of the basophil nucleolus (BP).

*Fig. 5.*—Nucleus of an oöcyte at a later stage of development, showing the remains of the basophil nucleolus (B), and the basophil substance (FB), scattered upon the nuclear network. Extrusion of oxyphil substance (NE) is still proceeding.

*Fig. 6.*—Oöcyte at about the same stage of development as in fig. 5. The basophil nuclear substance (FB) is scattered throughout the nucleus and extrusion of the oxyphil substance (FO) is continuing (NE).

*Fig. 7.*—Nuclei of three spermatocytes (a, b, c) showing the appearance of the nucleolus (NL) during synizesis.

*Fig. 8.*—Oöcyte (OC) attached to trabecular wall (T), surrounded by "nurse" cell (NC), to which are fixed developing spermatozoa (H).

*Fig. 9.*—"Nurse" cell (NC) being drawn out, away from trabecular wall (T) by metamorphosing spermatids (SP). The elongated nucleus of the "nurse" cell has two large nucleoli.

section and produce a type of artifact which is apt to be confused with chromidia. An instance of such confusion is the basophil cloud which Gatenby described at certain stages as occurring at the side of the nucleus of the young oöcytes of the frog. Later, Gatenby applied the modern technique for the cytoplasmic organs to investigate the nature of the "chromatin-like" mass apparently issuing from the nucleus. He found it to be mitochondria. Probably there was an extrusion of some liquid from the nucleus into the cytoplasm, which stimulated the mitochondrial complex of the young oöcyte into activity, but the extruded substance was not chromatin granules.

In considering the rôle of the nucleolus during gametogenesis and embryogeny, it is desirable therefore to consider the part played by the cytoplasmic organs. This has been fully described by Gatenby in the case of *Limnæa stagnalis* (11).

The young oöcyte contains Golgi elements or dictyosomes arranged concentrically around the archoplasm, and mitochondria surrounding it in the form of a cloud. The behaviour of these two organs during oögenesis appears to be essentially similar to that of *Patella* previously described by me—i.e. the Golgi elements increase in number by fission and spread out in the cytoplasm, and while so doing lead to the formation of yolk bodies. The mitochondria merely divide and scatter more or less evenly throughout the cell; they appear to become somewhat enlarged, probably with reserve food substance. At maturation, the egg contains yolk bodies, unchanged Golgi elements and mitochondria dispersed irregularly in the cell.

During spermatogenesis, the Golgi apparatus and mitochondria persist in the cell until the spermatid stage is reached, then during the formation of the tail, the Golgi apparatus is apparently sloughed off, and the mitochondria undergo a chemical change and form a kind of sheath around the axial filament.

During segmentation of the ovum, both Golgi apparatus and mitochondria persist irregularly scattered in the cytoplasm. Neither disappears during organogeny. In figs. 14, 16, Pl. IV, is shown the appearance of these organs in osmic acid preparations during the early segmentation and blastula stages. The cytoplasmic organs have been drawn to scale from the figures given in the paper previously referred to (11). Professor Gatenby has also allowed me to examine some of his preparations showing the same.

In the present research no fixatives containing osmic acid have been used, but only those whose constituents are known to destroy and remove all traces of the cytoplasmic organs.

#### BEHAVIOUR OF THE NUCLEOLUS DURING OÖGENESIS.

The behaviour of the nucleolus during oögenesis is essentially similar to that previously described by me in the Mollusc *Patella*

(34). The oöcytes arise from undifferentiated germinal epithelial cells, two of which are drawn in fig. 1, Pl. III. The nuclei of these cells contain masses of chromatin (CR), and in most cases no nucleolus is visible. As soon as one of these germinal epithelial cells begins to grow and acquires the nature of an oöcyte, a large oxyphil staining nucleolus becomes apparent. A young oöcyte growing out, away from the trabecular wall of the ovatestis, is shown in fig. 2, Pl. III.

The nucleus contains a large spherical nucleolus (NL), with pseudopodia-like processes (NP). When the process NP in the figure was brought into focus under the microscope, the oxyphil staining substance NE was also in focus. This latter substance was apparently partly within and partly outside the nuclear membrane (N). It would seem, therefore, that it is a part of the nucleolus in the act of passing out of the nucleus. From the appearance of the nucleolus in this cell, it appears that at this stage it performs the same curious amœboid movements as have been observed in somatic cells growing in tissue cultures.

When the oöcyte has attained a certain stage of development, the nucleolus becomes differentiated into two parts, as occurs in *Patella*—one part continues to stain oxyphil; the other stains basophil. An oöcyte in which the nucleolus has become altered in this manner is shown in fig. 3. Here again extrusion of oxyphil nucleolar matter (NE) is taking place.

After the differentiation stage of the nucleolus is reached the two parts behave differently. A series of changes occur, the result of which is, that the oxyphil part of the nucleolus breaks up and is extruded from the nucleus, while the basophil substance also breaks up, but instead of being extruded is distributed evenly throughout the nucleus. At fig. 4 is shown the beginning of the disintegration of the nucleolus. The oxyphil staining part (OP) is considerably vacuolated; it is breaking up into fragments (FO) which are passing out from the nucleus into the cytoplasm.

The basophil part (BP) is also breaking up, and this is spreading out upon the nuclear network. In the later stage, shown in fig. 5, nearly the whole of the basophil part of the nucleolus has become scattered through the nucleus, leaving only the membrane (B) within which it was previously contained.

In the same cell fragments of the oxyphil nucleolar substance are seen in the process of extrusion into the cytoplasm.

At fig. 6 is shown an oöcyte towards the end of oögenesis. The basophil part of the nucleolus (FB) is scattered upon the nuclear network, while the remnants of the oxyphil material (FO) are passing out of the nucleus. The cytoplasm, it will be seen, contains numerous yolk granules (Y). The extruded oxyphil material undergoes a change in staining properties, becoming amphophil.

It soon disappears, apparently through being dissolved in the cytoplasm.

The function of the extruded nucleolar particles has been discussed by me in another paper (34). Owing to the fact that nucleolar extrusions occur at the beginning of yolk formation and continue throughout this process, there is every reason for believing that it stands in some functional relationship to the activity of the cytoplasmic organs, which throughout oögenesis are engaged in the formation of reserved food substances for the development of the embryo.

#### THE NUCLEOLUS DURING SPERMATOGENESIS.

The behaviour of the nucleolus during spermatogenesis has been described in a number of animals, and there is considerable uniformity in the process. I shall, therefore, restrict my description to one or two features of special interest in *Limnaea*.

Throughout spermatogenesis the nucleolus stains oxyphil; and there is no differentiation into two parts as occurs in the oöcyte nucleus. During the early prophases of the heterotypic division of the spermatocyte, the nucleolus is present as a spherical plasmosome held in the linin network. The disposition of the nucleolus during synizesis is shown in fig. 7, Pl. III. At *a* contraction of the chromatin elements is just beginning; the nucleolus is seen to be attached to the chromatin threadwork. Later stages are shown at *b* and *c*. It will be noticed, that as the chromatin threads contract they draw the nucleolus with them. Following this stage with the breaking up of the chromatin elements to form the diplotene chromosomes, the nucleolus apparently disintegrates, and by the time that the double chromosomes are definitely formed, the nucleolus can no longer be observed in the nucleus. It is interesting to note here, that although the chromatin threadwork during synizesis stains markedly basophil, the diplotene chromosomes, formed from it, after the dissolution of the nucleolus stain amphophil with basophil preponderance. It seems possible that the nucleolus has some connexion with this.

The minute size of the spermatid in *Limnaea* renders accurate observation very difficult, but so far as I have been able to see, there is no definite nucleolar body present at this stage, or during the formation of the spermatozoon. There is, however, considerable nucleolar activity in the sertoli or nurse-cells.

At about the time when the tails of the spermatozoa begin to form, they appear to exercise considerable attraction for cells of the oöcyte type. Some spermatids appear to group together near an undifferentiated cell of the germinal epithelium. Such a cell then seems to grow larger, and there is actual attachment between

spermatids and "nurse-cell." The result of this connexion leads to the enlargement of the nucleolus of the "nurse-cell," and two nucleoli are often formed. This is shown in fig. 9. The "sertoli" cell (NC) is here growing out away from the trabecular wall of the ovatestis. The nucleus is elongated and has two spherical nucleoli. During fixation the nurse-cell appears to have contracted, and the result is that a number of fine protoplasmic filaments (PR) are seen attached to the developing heads of the sperm-cells.

Other cases are met with in which the metamorphosing spermatids are attached to young oöcytes. In such cases the nucleolus of the oöcyte is either small or altogether absent.

At fig. 8 is drawn a very curious condition. As has been described in a previous paper (34), when the young oöcyte grows out away from the wall of the ovatestis, neighbouring cells of the germinal epithelium grow up around it and form a temporary follicle. Such an oöcyte is shown in fig. 8. The nucleus of the oöcyte (OC) has a large nucleolus (NL), spherical in shape, while that of the "nurse-cell" (NC) is elongated. The unique point about this is that developing spermatozoa (H) are also attached to the "nurse-cell." It would seem, therefore, that although the "nurse-cell" has grown into its present position as the result of some stimulus from the growing oöcyte, it also has a certain tactic (probably chemiotactic) influence upon the growing sperms. The actual formative processes going on in the sperm-cell have been described in the previous section of this paper. It is impossible to say what relationship exists between these processes and the function of the "nurse-cell." That there may be some nutritional relationship seems quite feasible; there is also the problem as to whether such connexion between two cells, one predominantly anabolic, the other katabolic, has anything to do with neutralizing chemiotactic attraction between the male and female germ-cells of the same individual, and thus preventing self-fertilization.

Very commonly "nurse-cells" with attached sperm-cells are found in the lumen of the reproductive organ. At fig. 10, Pl. IV, is shown a typical case. The nurse-cell is seen to be binucleate and in each part of the nucleus is a spherical nucleolus. Such a state of affairs may arise in one of two ways. Either the nucleus of the "nurse-cell" divides amitotically so as to exert a greater influence upon the metabolism of the cytoplasm, as Macklin observed in living cells (38), or the spermatids in the first place became grouped around two undifferentiated cells which subsequently fused. Observations on living cells can alone settle this problem. Fig. 11 shows another cell which has functioned as a "nurse-cell." All but a few sperms (H) have broken away from it. The nucleus (N) of the "nurse-cell" is in a curious lobed condition, and it looks very much as though one nucleolus (NX) is being extruded into the cytoplasm. The double nucleolus of

this cell possibly denotes that the nucleus has arisen by fusion of two nuclei such as are seen in fig. 10. Similar fusion of nuclei has been observed in tissue cultures.

#### THE NUCLEOLUS DURING FERTILIZATION.

The nucleus of the mature ovum contains little or no oxyphil nucleolar substance, and no definite nucleolar substance can be observed during the formation of the polar bodies. In fig. 12 is shown a sperm nucleus (H) which has penetrated the oöcyte. No nucleolus is visible, and the sperm-head stains faintly basophil. The division aster is seen in process of formation at A. A noteworthy feature of the ovum at this stage is the vacuolation of its cytoplasm. Similar vacuolation has been seen by other observers in eggs of various animals.

A later stage in fertilization is shown in fig. 13. Here the first polar body ( $P_1$ ) has been formed and is beginning to disintegrate; the second polar body ( $P_2$ ) has been just formed, and the female pronucleus (FP) is moving away towards the centre of the cell. At SN is seen the sperm nucleus. In both male and female pronuclei, the chromosomes are somewhat vesicular, and no definite nucleolus is discernible. The sperm aster (A) is seen passing towards the centre of the cell, where fusion of the pronuclei takes place.

Both male and female pronuclei stain very badly, which renders accurate observation most difficult.

#### THE NUCLEOLUS DURING EARLY SEGMENTATION STAGES.

A section of the four-cell stage is shown in fig. 14. The remains of the polar bodies are represented at  $P_1$  and  $P_2$ . The two micromeres are in process of division. Attention is drawn here to the absence of anything but yolk granules (Y) in the cytoplasm during cell division, in preparation fixed in corrosive acetic. In the megamere, mitochondria (M) and Golgi elements (GA) are shown as they appear in osmic acid preparations. The appearance of the so-called "resting" stage of the nucleus during these early stages is very remarkable. At fig. 15 is shown the nucleus of an eight-cell stage. A faint nuclear reticulum is distinguishable, and scattered about it are numerous very faintly stained globules, some of them stained slightly oxyphil (OV), others slightly basophil (BV). At NX is shown what appears to be an outflow of the faintly stained oxyphil fluid. A similar structure has been observed in numerous cells at similar stages of development, and in no case has a definitely formed nucleolus been seen.

THE NUCLEOLUS DURING THE BLASTULA AND  
GASTRULA STAGES.

By the time that a typical blastula stage is reached a well-marked oxyphil staining nucleolus is present in each cell. Fig. 16 shows a portion of a blastula wall. Two of the cells ( $CF_1$ ,  $CF_2$ ) have recently divided, and small nucleoli have just formed amongst the disappearing chromosomes (CH). In the cell below is seen a large nucleolus protruding from the side of the nucleus. Such an appearance is fairly common. Within the other cell, mitochondria (M) and Golgi elements (GA) are shown as they appear in osmic acid preparations. Part of another blastula is figured in Plate V, fig. 17. In the lowest cell, the chromosomes (CH) are seen forming upon the nuclear reticulum, preparatory to cell division. The nucleolus is shrunken in size, and instead of staining markedly oxyphil, stains slightly basophil. It is interesting to note that here again the change in staining reaction of the nucleolus takes place at the time when changes are occurring in the chromosomes. In the cell above, the chromosomes (CH) are grouped equatorially upon the spindle. In this metaphase, as in the previous cases, there is no sign of the nucleolus within the cytoplasm. The cell BC is remarkable in that it is binucleate; such a condition has been observed in several blastulae at this period of development. In the cell BC each part of the nucleus has a nucleolus, but this is not always the case, as is seen by referring to fig. 18*a*, where another double nucleus is drawn. Here the larger part of the nucleus has a quite big nucleolus, but

EXPLANATION OF PLATE IV.

*Fig. 10.*—Binucleate nurse cell with developing spermatozoa (H) attached. Each part of the nucleus has a large vacuolated nucleolus (NL).

*Fig. 11.*—Cell which has functioned as a nurse cell for spermatozoa with three still attached to it. The nucleus is curiously lobed, and has two large nucleolar masses, one of which (NX) appears to be in the act of extrusion into the cytoplasm.

*Fig. 12.*—Ovum in which the sperm (H) has just penetrated. The aster is seen forming at A. The cytoplasm contains numerous yolk granules and is considerably vacuolated (V).

*Fig. 13.*—Ovum, showing the polar bodies ( $P_1$  and  $P_2$ ), and the male (SN) and female pronuclei (FP). The division aster is shown at A. This figure has been drawn by superimposing drawings of four consecutive sections.

*Fig. 14.*—Section of an early segmentation stage.  $P_1$  and  $P_2$  are the remains of the polar bodies. The two micromeres are at the metaphase of cell division. The megamere is shown as it appears at this stage with Kopsch's osmic acid technique.

*Fig. 15.*—"Resting" nucleus of early segmentation stage. The nucleus contains numerous globules, some staining oxyphil (OV), others basophil (BV). The nuclear reticulum is scarcely distinguishable, and there appears to be an absence of basophil staining substance in the nucleus. At NX is shown what seems to be an extrusion of the faintly staining oxyphil substance.

*Fig. 16.*—Portion of the wall of a blastula, showing the characteristic oxyphil staining nucleolus. The cells  $CF_1$  and  $CF_2$  have just undergone mitosis.

none is observable in the smaller part. Macklin observed exactly the same condition in the cells of the embryo chick grown in tissue cultures, where the binucleate condition arose by the nucleus dividing amitotically. He saw similar nuclei fuse and then divide mitotically. The elongated nucleus in the cell CP has probably arisen by fusion of two nuclei such as those shown in the cell BC.

The binucleate condition appears to arise owing to the necessity for an increase in the surface of the nucleus in contact with the cytoplasm. Such an increase would facilitate the interchange of substances between nucleus and cytoplasm, and no doubt in such cells there is intense metabolic activity going on.

At fig. 18v is shown another nucleus from a cell of the same blastula. In this nucleus, the nucleolus is apparently fragmenting, and here considerable difficulty arises as to whether any of these nucleolar fragments are extruded into the cytoplasm. In Plate V, in most of the figures, certain granules labelled NX are shown coloured red. The greatest difficulty in the present research has been to ascertain whether these granules represent extrusions from the nucleus or whether they are fused metaplastic bodies. The difficulty arises because these granules stain almost, if not in some cases quite, identically with certain of the yolk granules. It may be suggested that in some cases they represent fused metaplastic bodies, for generally they are much larger than individual yolk granules; but my main reasons for suggesting that they are derived from the nucleolus are, firstly, that in some cases there appears to be continuity between parts of the granules inside and parts outside the nuclear membrane; and, secondly, that the parts of such granules farthest removed from the nucleus usually stain slightly basophil, and such a change of staining reactions is characteristic of nucleolar extrusions which have been described by other observers. While, therefore, I feel that there is fairly good evidence for believing that nucleolar extrusion does take place during development, I do not consider that the problem can be definitely solved by the study of fixed material. The ultimate solution lies in observations on the living cells, and the large amount of yolk substance in *Limnæa stagnalis* renders it unsuitable for observations *intra vitam*. Some other type is necessary for this purpose which can be grown in tissue cultures, and I am at present investigating the subject for future researches.

A typical gastrula is formed in *Limnæa* by the usual method of invagination. At later stages the mesoderm cells are cut off from endoderm cells around the blastopore, and come to lie between the ectoderm and endoderm. Considerable nucleolar activity takes place during their growth and development. They are distinguishable from the other cells of the ectoderm and endoderm at early stages, by the greater oxyphility of their cytoplasm.

In figs. 19 and 20 are shown three such cells from late gastrulæ. The smallest cell in fig. 20 has a small nucleolus just forming as the chromosomes are diffusing after cell division. In the other cell the nucleolus is larger relatively and is vacuolated. The larger mesodermal cell in fig. 20 contains a considerable amount of nucleolar substance. The granules NX very probably represent parts undergoing extrusion. Similar activities are represented in the cells marked ME in fig. 24. The condition of the nucleolus in the mesoderm cell shown in fig. 21 is unique. A part of it is prolonged into a kind of pseudopodium; the greater part of it is spherical, and consists of a peripheral layer of markedly oxyphil substance (NR), internal to which is a less oxyphil staining area which appears to be a kind of vacuole. It seems probable that the substance marked NX represents a distal extruded portion of the pseudopodial process NP.

The endodermal cells during development undergo considerable changes. At fig. 22, two such cells from a recently formed gastrula are shown. In both a large nucleolus is present in the nucleus, and within the cytoplasm are numerous vacuoles (V). In the upper cell the nucleolus is double, the larger part being vacuolated; the nucleus on the right-hand side is somewhat concave, and within the concavity is the granule NX, surrounded by a clear region of the cytoplasm. Either this granule is a metaplastic one, and is the cause of the concavity of the nucleus, or it represents a portion of the nucleolus which has been extruded and is dissolving in the cytoplasm. From its size, staining reaction, and general disposition, I am inclined to favour the latter view as to its origin.

#### THE NUCLEOLUS IN THE LARVAL AND ADULT STAGES.

From endodermal cells such as are shown in fig. 22, develop large cells such as the one drawn at fig. 23. The numerous small vacuoles increase in size and number and come together to form one or two very large ones, which lie at the end of the cell, distal to the archenteron. The nucleus also enlarges, and most characteristic of it, is the large nucleolus, which is usually vacuolated.

Some of the cells in the region of the stomodæum of a larva are shown in fig. 24. An ectodermal cell at prophase is shown at CP. With the formation of the chromosomes (CH), the nucleolus has disappeared. Another ectodermal cell at telophase is shown at CT; amongst one of the groups of chromosomes is seen a small red sphere which would appear to be the beginning of the nucleolus. All the cells in the "resting" condition have a nucleolus, and in some of them are shown granules (NX) which are very possibly nucleolar in origin.

Figs. 25 and 26 show cells from a later larval form—the free-

swimming trochosphere. In fig. 25 is an ectodermal cell (ET) in which the nucleolus has fragmented, and this seems an almost definite case of nucleolar extrusion. No doubt such a condition arises by the breaking up of a nucleolus, the same as that shown in the adjoining ectodermal cell. The metaphase of the mesodermal cell ME, is another example where no nucleolus is visible during cell division.

In fig. 26 are drawn four ectodermal and three mesenchyme cells. The nucleolus in one of the ectodermal cells is single and spherical; in two of the cells, one ectodermal and one mesodermal, it is seen in process of division (DN). The problem arises here as to whether a portion of the nucleolus is extruded into the cytoplasm. The position of the granules NX seems to indicate that parts of the nucleolus may be thrown out of the nucleus into the cytoplasm, where they diffuse.

Portions of the tissues of the adult animal are shown in figs. 27 and 28. The former represents the ciliated epithelium of one of the ducts of the digestive gland; the latter some of the secretory cells of the same glands. The feature of importance is the relative inactivity of the nucleolus in the epithelial tissue compared with that of the secreting cells. No nucleolar extrusion is apparent in the first case, but there is strong evidence for regarding the granules NX in the gland cells as of this nature.

#### DISCUSSION.

(a) *Number of Nucleoli during Gametogenesis and Segmentation.*—There is remarkable variation in the number of nucleoli present in the nucleus of animal cells during gametogenesis and segmentation. In *Limnæa* I have observed no definite nucleolus in either the pronuclei or the early segmentation stages of the ovum. Griffin (18), who worked out the maturation, fertilization and cleavage of the Echiuroid *Thalassema* and the Lamellibranch *Zirphæa*, also does not figure any nucleoli at the same stages. The case of the mollusc *Zirphæa* is specially interesting in this connexion because a double nucleolus is present in the oöcyte similar to that which I have described. Hartmann (22), too, who worked on the opossum, *Didelphys virginiana*, makes no mention of a definite nucleolus in the gamete nuclei, but the nucleolus during embryogeny is well marked. Attention is drawn by Hartmann to the vacuolation of the cytoplasm of the ovum, such as I have described and figured.

In contrast to these observations we have cases where the nucleolus is well marked in both gametes. Walton (60) describes in *Ascaris canis* that, preparatory to the first maturation division, the plasmosome of the oöcyte nucleus degenerates and disappears *in situ*, some of its elements being extruded into the cytoplasm.

The pronuclei have numerous small plasmosomes, and during fusion of the gametes, the plasmosomes come together to form a large spherical nucleolus.

The case of the sponge worked out by Gatenby (12) is similar. Here the sperm is carried to the egg by a modified collar cell. Before entering the egg it has a single nucleolus, but on entering the egg the whole cell begins to grow and other nucleoli appear. The female pronucleus also has numerous nucleoli, and well-marked nucleoli are present during segmentation of the ovum.

During artificial parthenogenesis of the egg of the sea-urchin *Strongylocentrotus purpuratus*, changes have been observed in the nucleolus. Jenkinson (29), quoting the observations of Hindle (26), says that well-marked changes occur in from fifteen to twenty minutes between removal from the butyric acid and immersion in the hypertonic salt solution. The fertilization membrane of the egg is first thrown off, then the nucleolus loses its affinity for dyes, and also its shape. It may fragment. In the hypertonic salt solution the nucleus enlarges, and this is still more marked on transferring again to sea-water. These observations point to the probability of the variations in nucleolar number and behaviour being due to different metabolic conditions in the nuclei.

#### EXPLANATION OF PLATE V.

*Fig. 17.*—Another section through a blastula, showing a binucleate cell at BC, chromosomes at metaphase at CH, and the disintegration of the nucleolus (NY) preparatory to mitosis.

*Fig. 18.*—Two other nuclei from the same blastula. At "a" another double nucleus; at "v" nucleus showing fragmentation of the nucleolus (NL).

*Fig. 19.*—Mesoderm cell of gastrula, showing the large amount of nucleolar material (NL) and possible extrusion.

*Fig. 20.*—Two mesoderm cells recently separated from the endoderm, to show the growth of the nucleolus.

*Fig. 21.*—Another mesoderm cell with large nucleolus, which is surrounded by a peripheral layer of deep staining substance, inside of which is a fainter staining material; pseudopodia-like process at NP, and possible extrusion at NX.

*Fig. 22.*—Two endoderm cells at early gastrula stage. The cytoplasm of each contains several vacuoles. At NX is shown what is believed to be a nucleolar extrusion.

*Fig. 23.*—Endoderm cell of the trochosphere larva, showing the large vacuole (V) and the considerable growth which has taken place in nucleus and nucleolus.

*Fig. 24.*—Section of larva at the region of invagination of the stomodæum. Cell at prophase shown at CP, another at late telophase at CT. Possible nucleolar extrusions denoted by NX.

*Fig. 25.*—Part of wall of larva, showing a good example of nucleolar activity at ET.

*Fig. 26.*—Ectodermal (ET) and mesenchyme (ME) cells of trochosphere larva, showing nucleolar activity and probable extrusions.

*Fig. 27.*—Part of the ciliated epithelium of a duct of the digestive gland, showing the relatively inactive nucleoli (NL).

*Fig. 28.*—Secreting cells of the digestive gland, showing the vacuolated nucleoli with pseudopodia-like processes (NP). At NX possible nucleolar extrusion.

(b) *Size of the Nucleolus.*—There has been considerable discussion in the past over the relative sizes of the different cell organs at the various stages of development, and we have the opposite views of Minot (41), who attributes senescence to a decrease, and Hertwig (25) to an increase, of nuclear as compared with protoplasmic material. Conklin (7), on the other hand, agrees with Child that “senescence seems to be associated with a decrease, and rejuvenescence with an increase of metabolism.” Conklin further adds that “anything which decreases the interchange between nucleus and cytoplasm decreases metabolism and leads to senescence; anything which facilitates the interchange increases metabolism and leads to rejuvenescence.”

With regard to the nucleolus, Conklin says: “The size of the nucleoli (plasmosomes) depends upon the size of the nucleus and the length of the resting period; the larger the nucleus and the longer the resting period, the larger the plasmosome becomes. In eggs in which the nuclear division has been greatly delayed, if not entirely stopped, by the use of hypertonic salt solutions, the nucleoli become much larger than in normal eggs.”

My own observations agree with those of Conklin in some respects. That the nucleolus in certain “resting” cells does enlarge considerably can be seen by reference to the huge nucleolus in the endodermal cell shown in fig. 23. All the figures in my third plate from 19 to 28 are drawn to the same scale. The nucleoli in the “resting” somatic cells shown in figs. 27 and 28 are decidedly smaller than those in certain of the embryonic cells, e.g. the cells shown in figs. 19, 21, 23 and 26. I am inclined therefore to regard the size of the nucleolus as an indication of the degree of metabolism existing in the cell—the greater the metabolic activity, the larger the total volume of nuclear matter present in the nucleus, or extruded in the cytoplasm. In this connexion the epithelial cells of fig. 27 should be compared with the gland cells of fig. 28.

(c) *Interchange of Materials between Nucleus and Cytoplasm.*—In considering this aspect of the subject it is important to note:

(i.) That after each cell division the amount of chromatin comprising the chromosomes in each nucleus is halved; therefore during growth and preparation for the next division the amount of chromatin has to be increased. We cannot regard the whole of the chromosomes as being derived by division from those of the egg, and therefore the raw materials which are to be built up to form chromatin must be derived from the cytoplasm. Whether we can observe the process or not, the nucleus must therefore absorb substances from the cytoplasm for both structural and metabolic purposes.

(ii.) That the cytoplasm of the egg possesses potential energy in the form of yolk; there is no such store of reserve food substance

or accumulation of energy within the nucleus, as far as we know. Therefore both raw material for structural purposes within the nucleus, and the energy for the vital activities must be supplied during early stages of growth by the cytoplasm.

(iii.) That the chromosomes as the physical bases of heredity, during development must be continually exerting their controlling influence upon the cytoplasm; this they probably do by a kind of enzyme action. The weakness of binuclear theories previously referred to is, that they split the functions of the nucleus into two separate groups—the one nutritional, the other hereditary—whereas the two are really one. The various hereditary characteristics are probably due to the type and nature of the metabolic processes existing in the cells of the developing embryo; the varying nature of the chromosome influence upon the cytoplasm producing the different hereditary characteristics. Whether this aspect of the subject is admitted or not, the fact that there must be an extrusion of substances from the nucleus into the cytoplasm is undeniable.

The only types of extrusion from the nucleus into the cytoplasm so far described are, firstly, chromatin extrusions of which we have practically no undisputed evidence, and, secondly, nucleolar extrusions. The question arises as to whether nucleolar extrusions represent substances elaborated by the chromosomes for the purpose of exerting formative influences; or, in the language of physiology, are chromosomes a type of pro-enzyme, and nucleolar extrusions enzymes? I do not wish to do more than state the problem here; nothing but much further research can solve it.

It is necessary to point out however the conclusions of workers in experimental embryology, that “the larger characters, those of the phylum class, order and family to which the animal belong, are carried by the cytoplasm”; and that the smaller characters, generic, specific, variate and individual, are transmitted “through the male and female pronuclei (ibid. Jenkinson). Also at the same time the cytoplasm is during pre-maturation stages, indebted to the nucleus for certain elements in its structure” (29).

In connexion with the intaking of material by the nucleus from the cytoplasm, Montgomery (42) considered the nucleolus played an important part. He pointed out that in certain cases the nucleolus first makes its appearance as a small body attached to the nuclear membrane.

Other workers have observed basophil staining substances in the region of the nucleus, which they interpret as substances being absorbed by the nucleus. Nakahara (46), in a recent paper, describes such an occurrence in the oöcyte of the stone-fly, *Perla*. At the time when the basophil substance appears, the nucleus is relatively small, but at later stages, when the same substance can no longer be seen in the cytoplasm, the nucleus is much larger and contains large nucleoli. His explanation of the process is that the nucleolus

represents substances undergoing metabolic activities during their passage from the cytoplasm through the nucleus.

Danchakoff (8) has also given an account of a similar process in the egg of the sea-urchin, *Strongylocentrotus lividus*. Towards the end of oögenesis there is a large well-marked nucleolus in the oöcyte, but in the mature egg the nucleus is achromatic, and granules of a basophil staining substance are present in the cytoplasm. After fertilization, and at the beginning of artificial parthenogenesis, the small achromatic nucleus attracts these basophil granules towards it, and Danchakoff contends that they pass through the nuclear membrane and are converted into chromatin, from which the chromosomes are differentiated.

Criticism which must be brought forward against the work of these two observers is that they have used no techniques for demonstrating cytoplasmic organs. True, Danchakoff figures what she calls mitochondria, but they are not at all like the well-defined bodies one gets by the Mann-Kopsch or Champy-Kull methods. When one bears in mind the earlier misinterpretation of the basophil substance of the frog's egg (to which reference was previously made) that turned out to be mitochondria badly fixed, one realizes the necessity before accepting these observations, of further investigations on the activity of the cytoplasmic organs while these so-called processes of nuclear absorption are taking place.

With regard to the basophil bodies which are found in the cytoplasm during certain stages of cell division, Tennent (57) finds that they are not chromidia, as several observers have concluded, but that they arise as the result of indirect nuclear activity. As to their origin he suggests that suspensoid particles which are surrounded by emulsoid particles, coalesce, as a result of dehydration produced by an enzyme, which is emitted by the nucleus and passes into the cytoplasm. The change is reversible, and the basophil particles again pass into solution at a later stage of cell division.

(d) *Biochemical Considerations.*—From the physico-chemical point of view, Moore (43) says we should regard the cell "as a machine or mechanism through which there is constantly taking place a flux of energy. The cell is continually taking up energy from its surroundings in certain forms, and redistributing this energy in other forms, but in the process, it itself undergoes little or no permanent changes." The chromosomes are an example of the stable cellular mechanism, but the nucleolus is undergoing continual changes.

Of the energy changes, Moore says that the living cell can, in common with unorganized catalysts or enzymes, "(a) commence a reaction which does not proceed at all in its absence, and (b) alter the velocity of a reaction which does proceed in its absence, and

such action may be positive, increasing the speed of reaction, or negative, diminishing the speed of reaction."

In addition to this, "the cell can store up chemical energy, either by using energy in other forms and converting it into chemical energy, or by linking several reactions together, and transforming the chemical energy obtained from some, back to chemical energy which is stored up in others. Finally, the cell can modify its activities, and alter its action as a transformer, changing entirely the course of the reaction it induces and the products obtained, while the type of action of the enzyme is simple, selective, and entirely fixed."

The specific function of certain chromomeres shown by the work of Morgan (48) leads one to think that perhaps their influence is exerted upon the cytoplasm by enzyme action; and with regard to this reaction it should be noted that any one enzyme is only capable of effecting a particular molecular structure or grouping. Should enzymes be formed within the nucleus in appreciable amount, they would appear in fixed material, as they have been found to be colloidal and not to diffuse through parchment membranes; at least if they do so the process is very slow, therefore we should expect them to coagulate and stain. It is suggestive to observe here that the nucleolus usually makes its appearance amongst the chromosomes after cell division, and even in those cases where no nucleolar extrusion has been observed, during mitosis part of the nucleolar substance possibly dissolves in the cytoplasm. As we have scarcely any evidence for chromatin extrusions from somatic and developing cells, and a considerable number of observations upon extrusions of nucleolar substance, it is not improbable that such extrusions represent the passing out of the nucleus of enzymes elaborated by the chromosomes.

The view of some observers that preparatory to chromosome formation, during the prophase of cell division, there is combination between chromatin and nucleolar material, may be explained on this hypothesis by regarding the nucleolar material which combines with the chromosomes as anti-enzymes, which temporarily put a stop to the enzyme activities of the chromosomes. During the telophase these anti-enzymes collect together again to form the new nucleolus of the daughter-cells.

There is, however, another biochemical interpretation that can be applied to the facts available. Chemically the nucleus is characterized by nucleo-proteids. When these are decomposed they form nuclein and protein. Nuclein can be hydrolysed into nucleic acid and protein, while nucleic acid breaks down into phosphoric acid, carbohydrate and purine and pyrimidine bases. These changes are all induced by enzymes. The purine bases are deamidised by other enzymes, and the final oxidation product is uric acid (47). In the breaking down of complex molecules,

energy is liberated and can be used by the cell for other purposes as described.

Nakahara (44) believes that the nucleolar substance extruded from the nucleus of the silk-gland cells of insects gives off phosphorus and forms a lower member of the nuclei series. Transformation of nucleolar extrusions into albumen granules is described by the same writer in adipose cells of insects undergoing active metabolism; and Schreiner (51) has described the formation of fat globules from nucleolar extrusions in *myxine*.

The critical point in these cases is whether it is the nucleolar substance itself which is altered chemically, or whether it is the cytoplasm in which the enzyme had diffused. If it is the nucleolar substance itself that is so changed chemically, then either the enzyme must pass out of the nucleus, or be present in the cytoplasm; in that case the nucleolus represents an accumulation of products of metabolism within the nucleus, either secretory or excretory. On the other hand, if the nucleolar extrusions are not themselves transformed chemically, then they would seem to be of the nature of enzymes liberated from the nucleus, and the nucleolus would be an important organ of nutrition. In those cases of nucleolar extrusion described in *Limnæa*, the extruded nucleolar material seems in all cases to dissolve and diffuse in the protoplasm.

(e) *Extrusions from the Nucleus into the Cytoplasm during Cell Division.*—Quite apart from the extrusion of nucleolar material from the nucleus of the resting cell, it is a significant fact that when cell division takes place, the whole of the nucleolus with the exception of the nucleolus appears to disintegrate and a part probably diffuses into the cytoplasm. In all cases of mitosis, which have been observed in my material, no nucleolus was discernible during metaphases or anaphases, but it disappeared at prophases and reappeared at late telophases.

As is seen at Plate V, the nucleolus of embryonic cells is by no means small in comparison with the size of the cell, so that at each mitosis there is possibly some nucleolar material together with karyolymph extruded into the cytoplasm. The possibility of elimination of nucleolar material from the nucleus during mitosis, offers a likely explanation of the comparative rarity of nucleolar extrusions during embryogeny when it might be expected to occur most often. It seems that in the newly formed embryonic cell, the chromosomes spread out to form the nuclear reticulum in order to exert their maximum influence during metabolism. The nuclear membrane is formed, and as microdissection has shown (48) this is of a gel-like consistency, and no doubt exerts a selective influence, determining what substances shall pass into, and out of the nucleus during the "resting stage." Material passing into the nucleus is utilized for building up chromatin to restore the normal

size of the chromosomes reduced to a half by mitosis, while other substances under the influence of the chromosomes (probably enzyme action) become converted into the materials of the nucleolus and karyolymph. It may be that the latter are secretory substances, or of the nature of enzymes, or even materials no longer needed for nuclear activities, but capable of yielding energy when metabolized in the cytoplasm. Whichever be the true explanation, and there may be elements of truth in each of these suggestions, there is no doubt that when the cell divides a part of these materials is returned to the cytoplasm from which they originally came, and this process is repeated with every cell division. Sometimes nucleolar extrusions occur during the resting stage of embryonic cells, but such an occurrence is related to a relatively higher degree of metabolism. However, in the resting cell where cell division is rare, or does not occur, the only way for the nucleolar material to reach the cytoplasm is by extrusions, and the higher the rate of metabolism the greater the frequency of its occurrence. This may afford an explanation of the absence of the nucleolus in inactive cells such as the undifferentiated cells of the germinal epithelium, of the comparative infrequency of nucleolar extrusions in embryonic cells, and the common occurrence of this process in active cells such as gland cells and nerve cells.

(f) *The Nucleolus and Morphological Changes in the Chromosomes.*—There is another quite possible function which the nucleolus may serve. It may be related to the morphological changes which take place in the chromosomes during cell division. The main facts supporting such a view as to this function are:—

- (a) That when the nucleus is about to divide, the nucleolus becomes smaller and progressively achromatic at the same time as the chromosomes are being formed from the nuclear reticulum and are becoming more chromatic (CP in fig. 17).
- (b) That at the telophase of division when the chromosomes are spreading out to form the network of the "resting nucleus," and losing their affinity for dyes, the nucleolus makes its appearance as a small oxyphil staining body amongst the nuclear network. It grows in size, while the chromosomes become progressively more dispersed and less chromatic (CF<sub>1</sub>, CF<sub>2</sub> in fig. 16).
- (c) That during the synizesis stage of spermatogenesis, the nucleolus is drawn towards the contracted chromosome complex (fig. 7), and it disappears from the nucleus as the definitive chromosomes of the diakinetik stage appear.

Recent researches on the nucleus have led us to regard each chromosome as an amoeboid body, which during the "resting

stage" of the cell consists of long branched filamentous pseudopodia which are linked up at their extremities with similar outgrowths from other chromosomes so as to form the nuclear network. Upon this network is arranged the chromatin in minute granules. This fundamental structure, consisting of the essential chromosome material, and the framework upon which it is supported, is believed by many writers to be almost achromatic (48) in the "resting cell" during intense metabolic activity. In the network of the nucleus, however, is the nucleolus, which has a strong affinity for dyes.

During the prophase of mitosis, each of the "amœboid" chromosomes appears to withdraw its pseudopodia, the chromatin granules are brought close together, and at the same time the nucleolus disintegrates and the chromosomes show a strong affinity for dyes.

It almost seems as though we have here a case of cause and effect—breaking down of nucleolus, and building up of compact chromatic chromosomes from the diffused reticular form. A possible explanation of this, is that some of the nucleolar material reacts with the spread-out chromosomes, in such a way as to cause them to contract or condense, and at the same time become more stable chemically. We should expect some such chemical change in the constitution of the chromosomes during cell division, as it is essential that the daughter chromosomes should retain the same chemical constitution as the parent ones, and this would be ensured by the chromosomes becoming more stable chemically during cell division.

After cell division, the chromosomes throw off this nucleolar substance, spread out to form a reticulum, become less achromatic, and less stable chemically, but more active hence the appearance of the nucleolus at the same time as the chromosomes begin to spread out to form the nuclear network.

In support of this hypothesis it should be noted—

- (a) That the chromosomes are usually but faintly distinguishable in the actively functioning cell, but the nucleolus is most conspicuous, e.g. oöcytes of animals such as *Echinus* and *Scyllium*.
- (b) That relatively inactive cells, such as those of the germinal epithelium of *Limnæa*, contain no nucleolus, but granules of chromatic material, which seems to indicate that the chromatin is combined with nucleolar material, and is chemically stable, but relatively less active.
- (c) That in binucleate cells where two nuclei are formed amitotically, and both nuclei do not contain a nucleolus, the chromosomes are only reformed after fusion of the two nuclei, and the chromosomes reappear at the same time as the nucleolus disintegrates. This process has been observed by Macklin in living cells (38).

Opposed to such a hypothesis, are the observations of certain workers who have described the casting out of the nucleolus from the nucleus preparatory to mitosis. In a large amount of material, both animal and plant, which I have examined, I have not observed this occurrence during any mitosis. If such a process does take place, it must be exceptional, and as a part of the nucleolar material possibly remains in the nucleus, it does not seriously militate against this view.

In concluding this aspect of the subject, it is desirable to point out that such a theory as this does not in any way involve interference with the theory of the integral continuity of the chromosomes throughout the life cycle, and also it does not assume that this is the only function of the nucleolus. In fact, we should imagine the chemical constitution of the nucleolus to be one of considerable complexity, and capable during metabolism of breaking down to form a number of compounds of a simpler chemical constitution, which may play an important part in the vital activities of the cell. Some of this nucleolar substance may be extruded from the resting nucleus, and also a part may be thrown out into the cytoplasm during cell division, and there undergo metabolism.

#### GENERAL CONCLUSIONS.

Consideration of the foregoing has led me to the conclusion that the nucleolus, far from being a mere accumulation of waste products of the nucleus, has a most important part to play in the nutrition of the cell. It may represent elaborated enzymes, or the accumulation of secretory or excretory substances, which by enzyme action and oxidation will be broken down with the liberation of energy. Also, it is possible that it stands in some functional relationship to the morphological changes which take place in the chromosomes at different periods of cellular activity.

As to how far each, or all of these suggestions are correct, it is impossible to say until more facts are available.

#### SUMMARY OF THE RÔLE OF THE NUCLEOLUS IN THE GERM-CELL CYCLE OF *LIMNÆA STAGNALIS*.

##### A. During Oögenesis.

1. In the undifferentiated cells of the germinal epithelium, there does not appear to be any nucleolus (fig. 1).
2. As soon as an undifferentiated cell begins to differentiate, and grow into a gonocyte, an oxyphil staining nucleolus is formed in the nucleus (fig. 2).
3. With growth of the oöcyte, the nucleolus increases in size, performs amœboid movements, and portions of it are extruded into the cytoplasm (fig. 2).
4. When the oöcyte has attained a certain stage of development, the

nucleolus becomes differentiated into two parts, one still stains oxyphil, the other basophil (fig. 3).

5. Throughout oögenesis, the oxyphil nucleolus appears to extrude portions of itself into the cytoplasm; this process is most active towards the end of oögenesis, when the oxyphil nucleolus becomes vacuolated and breaks up into numerous small nucleoli, most of which pass out into the cytoplasm (figs. 4, 5, 6).

6. The basophil staining part of the nucleolus persists until the end of oögenesis, when it breaks up and forms a granular substance, which becomes evenly distributed throughout the nucleus, and in fixed material appears as small accumulations of basophil material arranged upon the nodes of the nuclear reticulum (figs. 4, 5, 6).

7. No definite nucleolus is visible in the nuclei of the polar bodies or in the female pronucleus (fig. 13).

### *B. During Spermatogenesis.*

1. An oxyphil staining nucleolus is present in the spermatocyte. There is no basophil staining nucleolus, and no differentiation into two parts as occurs in the oöcyte (fig. 7).

2. The nucleolus persists in the spermatocyte until the synizesis stage of the reduction division. When the chromosome threadwork undergoes contraction, the nucleolus is drawn into the contracted chromosome reticulum (fig. 7). During diakinesis no nucleolus is distinguishable, but the chromosomes stain less basophil than they did during synizesis.

3. No nucleolus was discernible in the spermatid during its metamorphosis into the spermatozoon (fig. 9).

### *C. In the Sertoli Cells of the Ovatestis.*

1. The influence of the sperm cells upon the sertoli, or "nurse-cells," is such that the nucleolus of the "nurse-cell" nucleus is characteristically enlarged (figs. 8, 9, 10, 11).

2. The "nurse-cells" attached to the developing spermatozoa are often binucleate, and a large nucleolus is usually present in each nucleus (fig. 10).

3. When there is only one nucleus in the "nurse-cell," it is usually elongated and contains two nucleoli, one at each end of the nucleus (fig. 9).

4. There is a probability of nucleolar extrusion taking place in the "nurse-cell" after the sperms have become detached from it (fig. 11).

### *D. During Fertilization.*

Nucleoli are either altogether absent from the pronuclei, or else they are achromatic, for none can be seen in the pronuclei before, or for some time after their fusion (fig. 13).

### *E. During Early Segmentation Stages.*

1. During cell division the chromosomes have their normal appearance. No granules other than yolk bodies and cytoplasmic organs have been observed in the cytoplasm, and there is no evidence of any germ-cell determinant derived from the nucleolus or chromatin (fig. 14).

2. The nucleus of the "resting cell" presents a remarkable appearance. On a just distinguishable nuclear reticulum, numerous globules are to be seen, some stain faintly basophil, others slightly oxyphil. There is some evidence for believing that the latter may be extruded into the cytoplasm (fig. 15).

F. *During late Blastula and Gastrula Stages.*

1. An oxyphil staining nucleolus is present in all cells (figs. 16-22).
2. Binucleate cells have been observed in early blastula stages (fig. 17). In some binucleate cells each nucleus has a nucleolus; in others, a single large nucleolus is present inside the larger nucleus (fig. 18a).
3. At each cell-division, the nucleolus disappears at the time when the chromosomes are reforming, and it makes its appearance again as a small oxyphil staining body amongst the chromosomes at late telophase (figs. 16 and 17).
4. Mesoderm cells arising in the gastrula, are characterized by the oxyphility of their cytoplasm, and the great activity of their nucleoli, which usually attain a considerable size, and often are seen fragmenting (figs. 19, 20, 21).

G. *In the Larval and Adult Stages.*

1. During the early gastrula stage, the endoderm cells contain a small nucleolus, and numerous small vacuoles in their cytoplasm (fig. 22). In the larva stage, however, such cells increase enormously in size, the vacuoles run together to form a few large ones, and the nucleolus enlarges considerably (fig. 23).
2. Actively growing cells are characterized by their large nucleoli, and by the fragmentation and division of the same (figs. 19, 25, 26).
3. In the adult, nucleoli of cells undergoing active metabolism are relatively large, those in "resting" conditions relatively small (figs. 27, 28).

H. *Nucleolar Extrusions.*

1. Extrusions of oxyphil staining nucleolar substances occur during oögenesis (figs. 2-6).
2. Reasons have been advanced for believing that similar extrusions of nucleolar material occur in rare cases during development, and also in cells of the adult during conditions of great metabolic activity (figs. 19, 21, 22, 24-26, and 28).

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## VI.—THE MICROSTRUCTURE OF COAL FROM AN INDUSTRIAL STANDPOINT.

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TWO PLATES.

It is now almost one hundred years since the microscope was first used to examine thin sections of coal. Early papers show that Witham used the microscope for this purpose in 1832 to 1833, and that he was closely followed by Hutton and Lindley. Quite an appreciable number of papers dealing with the microscopy of coal were published in this country and abroad, during the succeeding forty or fifty years. Then followed a period when interest in the matter lay dormant, but during the last twenty years a revival has taken place, and a very promising field of work seems to be opening up. Stopes and Wheeler, at the end of a "Monograph on the Constitution of Coal," published in 1918, give an excellent bibliography of the published work from 1832 to date.

Most of this work deals, however, with the constituents of the coal substance, or with theoretical considerations which attempt to account for the formation of coal; but as yet, little work appears to have been done on the use of the microscope in fuel selection from an industrial point of view.

The worker in an industrial laboratory has two important considerations to keep always in mind. First, the works must be kept running. (This applies generally, but with particular force to a fuel laboratory.) Secondly, the works must be run as economically as possible, and no matter how empirical or comparative the methods of work may be, if they help towards better and more economical working they justify themselves.

This applies in the case of ordinary chemical analysis of coal, and it may even be said of the use of the microscope in metallography. But though ordinary chemical analysis as applied to coal may justify itself, I would like first of all to point out its limitations—why it so often fails to give essential information—and then to show you the part the microscope can play in fuel selection.

The usual method of examining coal is to make a "proximate analysis." It has to be carried out under standardized conditions

of temperature, and with a standardized type of apparatus, to be at all comparative. The analysis usually consists of the determination of moisture, and on the dried sample, of the ash, the volatile matter and sulphur; a standardized coking test may also be made. The proximate analysis does not give very much information unless the type of coal is known, even when carried out under these conditions, due allowance being made for the varying ash content. A standardized coking test, too, is of doubtful value when the ash content is at all high, because a high ash content tends to destroy or modify the coking power.

The "ultimate analysis" of coal—that is, the determination of the percentage of carbon, hydrogen, oxygen, nitrogen and sulphur—on the other hand, has a fair degree of accuracy as its justification, and the results have been extensively used for chemical classifications. For this purpose the ratio between the carbon and hydrogen percentages is generally used. Ultimate analysis, however, is very limited in its application.

I have come to this conclusion, not only from the results of experience, but by reasoning from our present-day knowledge of coal; for it is not so much in accordance with their ultimate composition that coals vary, but according to the proportion and type of substance present in the coal conglomerate. The coal conglomerate is composed of plant remains. The plants then, as now, were mainly composed of cellulose, with ligno-cellulose, cutoses, and some resins and protein matter. Plant tissues in general are, chemically, very much alike; variations in a species, or in the different parts of the same plant, being due mainly to various polymerizations and condensations, etc., of the carbohydrates, so that the ultimate composition of the bulk of plants will be very similar. Admitting that this is so, and assuming that, in the case of coal, decomposition was fairly uniform, a coal would have to be composed, mainly, of some substance which differs markedly from the bulk of the plant remains to show any marked difference in its ultimate analysis. The hard or cannel coals are a case in point. During coal formation, however, the degree of decomposition undergone by the coal substance would

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#### EXPLANATION OF PLATE VI.

##### Numbers.

- 1 & 2.—Typical humic coal  $\times 75$ . Sections cut parallel with and at right angles to the bedding plane respectively.
- 3 & 4.—Spore coal showing spore exines  $\times 20$ . Parallel with and at right angles to the bedding plane respectively.
- 5 & 6.—Hard or cannel coal showing the small round "yellow bodies"  $\times 170$ . Parallel with and at right angles to the bedding plane respectively.
- 7 & 8.—A good steam-raising coal. Mainly humic, but containing much cuticle and spore exines. No. 7  $\times 20$  (parallel with bedding plane). No. 8  $\times 170$  (at right angles).

not be uniform. Some portions would undergo fairly rapid decay, while others would be covered and protected from bacterial and other actions, so that we might expect to find plant remains which are but slightly altered. These remains might, perhaps, be broken up, but not necessarily much altered in composition. The microscope, in fact, shows but slightly altered plant tissues, and various workers seem to agree that it is possible to dissolve out small amounts of cellulose from some coals. Cellulose contains a high proportion of oxygen and hydrogen in its molecule; and a small proportion of only slightly altered cellulose tissue in a coal will have a very marked influence on the ultimate analysis. It follows, then, that two coals which are composed of similar vegetable remains, may have very different ultimate compositions, without being very dissimilar in their general properties. In practice this is found to be so. I would repeat, it is not so much in accordance with the carbon, hydrogen and oxygen content that coals vary, but rather with the proportion and type of the different substances in the coal conglomerate. Chemical classifications do not take these points into consideration, and by chemical analysis, so far, it has not been possible to identify satisfactorily the various coal substances.

By far the greater part of the coal found in this country is classified by the usual chemical methods as "bituminous." The chief exceptions are the anthracitic coals of South Wales. It is with these so-called "bituminous" coals only that I intend to deal; so far as I am aware no really satisfactory sections of the anthracitic coals have been prepared. The "bituminous" coals are of great industrial importance, and consequently numerous attempts have been made to group them according to their behaviour when in use. It is obvious to even the most casual observer that there are great differences in coals when burnt, say, in an open grate. Some are fragile and ignite readily; others are very hard and difficult to ignite; some swell up and coke; while others burn away to ash without any formation of coke. Some coals burn with a long flame, others with a short one. Hence we get such terms as "dry coals," "fat coals," "lean coals," "long and short flaming coals," etc. Bone, in his book on "Coal and its Scientific Use," gives a modification of the Regnault Gruner classification (which is one of the earliest, and is based on the oxygen-carbon ratio of the coal—a most unsatisfactory method). The "bituminous" coals are divided into non-coking long flame, coking long flame, hard coking, and hard coking short flame.

Bone remarks, "The author's own investigations on typical English coals have brought to light some interesting examples of coals possessing quite different properties whose elementary compositions are very similar."

I have examined over two hundred different coals in the last

few years, during which time hundreds of analyses have been made, and I can say that this similarity occurs fairly frequently. From considerations already stated, it is obvious that this must be the case. It is, in fact, the converse of similar coals having different analyses.

These groupings are useful, and would be more so, were it not for the fact that the sharp distinctions of such classifications are not met with. In nature there is a gradual transition from one type to another. It is because of constantly recurring difficulties of this nature that the microscope was first brought into use in the hope that a better understanding in fuel selection might be reached.

The micro-structure was first applied to the selection of coal for a large twenty-two unit recovery gas plant, gasifying some 2,500 tons of coal per week, with the production of some 350,000,000 cubic feet of gas. In this plant, worked on the Mond principle, superheated steam and air are blown through a deep fuel bed. Excess of steam is used, and so the temperature of the producer is low, the out-going gases not being above 500° C. The coal is therefore subjected to a primary comparatively low-temperature distillation, and much of the "resinic" portion, which causes coking, is distilled off. It is possible in this type of plant to gasify practically any class of coal. A strongly coking slack, however, would necessitate a very slow rate of gasification and a large excess of steam, probably as much as two and a half tons per ton of coal, so that it would not be a commercial proposition to use such a coal. In practice as high a rate of gasification with as low a steam consumption as possible consistent with good gas and a high ammonia yield is aimed for. The producer is then running economically. Careful selection of fuel goes a long way towards obtaining efficiency and the satisfactory running of such a plant. The coals used are between the coking and non-coking types, and are consequently difficult to select ordinarily. Two coals may look alike, and give practically the same results in the laboratory, but when put into use one of them may be quite satisfactory and the other unsatisfactory. I give below the analyses of two such coals; one was used successfully in the recovery plant already mentioned, but the other could not be used economically:—

	Volatiles	Fixed Carbon	Total Carbon	Hydrogen	Oxygen	Nitrogen	Calorific Value, B. Th. Units per lb.
	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.	
No. 1 .. ..	33·2	61·8	82·2	5·83	11·21	0·76	14,750
No. 2 .. ..	33·1	61·9	81·2	5·60	11·93	1·27	14,750

The results are calculated on the dry, ash, and sulphur-free coals; the volatile matter is the loss on heating to 950° C. in a closed crucible surrounded by a larger crucible containing charcoal. The calorific value is by bomb determination.

The use of the microscope is comparative. Typical samples of coal which had been proved to be satisfactory, and others which were not satisfactory, were taken. Sections were cut in three directions and very carefully examined under the microscope. Photographs were taken, tinted to correspond to the actual sections, and the various coals compared. It was thought reasonable to expect that coals with a similar appearance under the microscope would behave similarly in practice. This was borne out in the works. It will be seen that it is a matter of experience and comparison upon which the method of use depends, and that it is not necessary to take into consideration the nature of the constituents of the coal for selection purposes, though one does so as a matter of interest. It is this comparative treatment which makes the method so empirical. Similar work was carried out with other classes of coal such as that used for non-recovery producers, steam boilers, direct-fired furnaces, coke manufacture, town's gas manufacture, etc.

It is quite possible by microscopic examination to pick out coals suitable for these purposes. It is usual to leave the final selection until a test has been run under working conditions, and in the running of such a practical test it is a great gain to know that unsuitable coals have been eliminated. With the ordinary methods of examination one can never feel certain, until a large scale trial has been run, that the fuel selected is the right one. Large scale trials are expensive, and if the coal is not a suitable one may have serious results.

From the study of industrial coal in general use, one is lead to the conclusion that it is possible to divide the so-called "bituminous" coals into three main classes.

One type is composed mainly of wood tissue. I use wood here in the strict sense, and not as it is generally used to denote timber. These are the soft humic coals which swell considerably on heating and form a very porous coke.

The second type has a predominance of spore coats and microspores. This class of coal is practically non-coking, a property which is to be expected when the main bulk of the coal is composed of spore exines. The "resinous" constituent of the humic coals which causes them to coke is most probably derived from the wood cell contents. This constituent is soluble in pyridine and chloroform, but the spore coals yield very little soluble matter on treatment with pyridine.

The third type consists of the hard coals or cannel. These are the non-coking long-flame coals, which are dull and compact.

A good specimen of this class is composed almost completely of the small round bodies about which, as yet, no definite opinion seems to have been formed. If the coal section is thin enough, the small round bodies are a bright yellow with a black centre. These black centres are most probably holes which have been filled in with carbonized material. Such a coal is quite non-coking, the residue being pulverulent. In thicker sections the small round bodies become more orange-coloured. Lomax, in one of his earliest papers (Lomax: "The Microscopical Examination of Coal," etc., *Trans. Inst. of Mining Engineers*, Vol. 42), states that the microspores form the bulk of cannels. This statement is of interest to me, because from examination of these bodies in other types of coal, I lean to the opinion that they are a variety of spore.

Of course, these classes are not sharp and distinct, but run into one another. There are humic coals which contain more and more spores; some coals are mostly spore, while others become cannellized as the yellow bodies merge with the spores. Some cannels contain many megaspore fragments, but others, as already stated, are almost wholly composed of yellow bodies. Cuticle from leaves and twigs, etc., is a constituent common to all types, but is more common in the humic to spore types.

Lomax, after studying a number of coal seams and cutting numerous sections, which when joined together made a thin slice of the coal, practically from floor to roof, comes to the following conclusions. That, in general, coal seams are composed as follows: First, there are the remains of ferns and horsetails; then come the Gymnosperms containing many cordiate leaves; the remains of the Lycopodæcia follow, forming the bulk of the coal. The spores from these trees become more and more numerous the higher up the seam one gets, microspores often occurring first. Cannels are found next, and then towards the top there is often a return to the remains of Gymnosperms and horsetails. (Lomax: "The Formation of Coal Seams," *T.I.M.E.*, Vol. 50).

This arrangement will account for the three types of coal found, and the gradual transition from one type to another.

#### EXPLANATION OF PLATE VII.

##### Numbers.

- 9 & 10.—Humic coals which swell very considerably  $\times 75$ . Town's gas manufacture and house coal.
- 11.—Humic coal with very fine structure  $\times 50$ . Suitable for coking. Right angles to bedding plane.
- 12 & 13.—Spore coals, suitable for producer gas working,  $\times 25$ . Parallel with and at right angles to the bedding plane respectively.
- 14.—Similar coal to above, but more cannellized,  $\times 15$ . Parallel with bedding plane.
- 15 & 16.—Hard coal almost completely "cannellized"  $\times 50$ . The round bodies are orange-coloured, due to the section being somewhat thick. Parallel with and at right angles to the bedding plane respectively.

It is an easy matter to distinguish between the soft humic coals and the hard cannel coals. The soft humic coal has a bright banded appearance, and it is divided by numerous cracks, mainly at right angles, which cause the coal to break into cubes. The hard cannel coal has a uniformly dull appearance, has few cracks, and is rather difficult to break. However, without the help of the microscope it is almost impossible to distinguish by their appearance the coals containing spores in a humic ground mass and those containing spores in a cannellized ground mass, particularly when the coals are in small pieces. Yet these are the coals which are of such vital importance to industry, particularly the iron and steel industry, for amongst them occur the true coking coals, the coals which are practically non-coking, and some excellent steam coals. The true coking coals are necessary for blast furnace coke manufacture, while the practically non-coking are essential for producer gas manufacture. Steam coals are, as yet, necessary to most industries. The necessity for using the best available means of identifying the various classes of coal will be apparent, and in view of the fact that our coal reserves are not unlimited, it is wasteful to use a coal for one class of work when it is more suitable for another.

In a short paper before the Iron and Steel Institute I dealt with the various uses to which these coals should be put. (Booth: "Economic Selection of Coal," Journal of the Iron and Steel Institute, No. 2, Vol. CII.)

The value of microscopical work in connexion with coal selection was demonstrated very clearly during the late war at the works of Messrs. Armstrong, Whitworth, Openshaw, the firm with whom I am associated. No doubt all of you will be aware that restrictions were placed upon long-distance transport of coal, and supplies could only be secured within a certain area. Neither could the usual sources within that area meet the increased demand, besides which usual supplies were sometimes curtailed owing to the Government having prior claims. As a consequence new sources of supply had to be tapped. Of these coals there was no previous experience, and careful selection was necessary, yet very many of them were rejected on microscopical evidence alone, little or no chemical analysis being done, and no large scale tests run. This was a great saving of time to the laboratory staff. Though there were many anxious times due to traffic delays, etc., at no time was there any inconvenience caused by the fuel department being unable to supply suitable types of coal to meet the various requirements of the works. If deliveries of a certain class of coal were temporarily stopped, it was possible, because of the more detailed knowledge gained from the microscopical work, to supply a similar class of coal or else the nearest type available. This knowledge made it possible to put into immediate effect any

alterations in the running conditions of the particular plant made necessary by the use of a different coal, and to issue instructions beforehand for any change in the working of the coal. This eliminated difficulties which would otherwise have arisen. Had the type of coal not been known any adverse effects could only have been combated as they arose. In some cases this would have meant delays for twelve to twenty-four hours after the coal had been put on. It might even have meant partial stoppage and a consequent drop in production, etc. So far I have attempted to show you something of the selection and allocation work of a fuel department in a large industrial works, where many classes of coal are in use for a variety of purposes. I have described for you these coals and the uses to which they should be put. I have also shown you how successful fuel selection can be made when a knowledge of the microstructure of the coal is used to supplement the information given by chemical analysis. I hope I have been able to convey to you some idea of the value of the microscope for this work when in the hands of an experienced technologist. I would now like to point out to you other uses to which the microscope can be put which are of considerable interest to industry. Of special interest commercially is the identification of the various coal constituents. Little is known as yet of the influence of varying amounts of the different constituents in a coal. I have briefly referred to the nature of some constituents, but it is more in regard to the nature of the resulting bye-products from coal-distillation that the microscopic study would be helpful. This question of bye-products has been studied extensively from the chemical side, which study tends to show that temperature plays a most important part in the nature of the bye-products. Two recent examples of chemical work might be quoted. Pictét and his co-workers have published some very suggestive work on the distillation of coal in vacuo. They show that the coal substance breaks down with the formation of alcohols and the cyclic paraffins, and that the more valuable aromatic compounds—namely, benzene homologues—are formed from these at a higher temperature (Pictét: *Rev. Gen. des Sec.*, Oct. 1916, Vol. XXVII.)

The control of temperature is of great importance in coke manufacture. S. Roy Illingworth (*J. Soc. Chem. Ind. Trans.*, Vol. XXXIX., Nos. 9 and 10) shows that it is possible to make a metallurgical coke from an apparently unsuitable coal by controlling the temperature. He also shows that it is varying amounts and differences in the coal constituents which cause changes in the behaviour of a coal. It will be realized that this kind of work is of great importance, but it gives no idea of the reasons why coals should vary to such an extent. It is in this connexion that I think a detailed microscopic study is vitally necessary. There is

now a vast accumulation of knowledge on the behaviour of coals under very diverse conditions of treatment, but strictly speaking the results are only applicable to those coals upon which the results were obtained. It is usual for the various workers to give a chemical analysis of the coal upon which they have worked; some give an ultimate analysis, others a proximate, though they often give it without any particulars as to the conditions of the analysis. As already pointed out these chemical analyses may be entirely misleading. If a description and illustration of the microstructure of the coal had been included as a matter of course, the value of this accumulated knowledge would be enormously enhanced. In all probability it would be possible from a study of the matter published to draw conclusions in regard to the influence of the coal constituents on the properties. Further means of verification and study would have suggested themselves. As it is the greater part of the published works lack the essential common factor whereby the whole can be correlated. A great step forward will have been made when workers on coal include a microanalysis in their results. Had such a course been followed in the past many misleading statements would never have been made. Various workers, for instance, have implied that the spore exines were resinous. It is now known that the "resinous" matter in coal is the cause of coking, and that after treatment with pyridine, in which the "resinous" matter is soluble, coals lose their coking properties; yet spore exines are found in the insoluble portion of the coal. Again, coals in which spore exines predominate are practically non-coking.

This microscopical study of coal constituents is essentially the work of the trained palaeobotanist. Stopes and Wheeler in their previously mentioned monograph summarize the possibilities in this direction, and describe many of the chief constituents of the coal substance. But before much can be said about the coal constituents methods will have to be devised for separating the chief ones and studying their behaviour under various conditions. The chemist must work side by side with the palaeobotanist and their results correlated. Real progress can only be made by combining the work of the two.

The microstructure of coal can give most valuable information, not only to the fuel technologist and palaeobotanist, but also to the geologist. The Geological Survey and the Fuel Research Board are co-operating in a survey of the British coal seams. It is to be hoped that a detailed account of the microstructure of the whole thickness of the seams will be included in their report. Such a survey is long overdue. From a national point of view it will supply most essential information as to the available resources of the various classes of coal. The coal owners and users would undoubtedly benefit by such a survey. Since the

coal resources of the country are in private hands the collieries themselves should contribute to the expense incurred.

The demand for coal has generally been equal to, or in excess of, the quantity raised, otherwise one would have expected the more enterprising colliery companies to have had made a detailed examination of their seams. One or two such surveys have been attempted but never completed. Such an examination would enable the collieries to state the types of coal they could supply. Much valuable hard coal is wasted through being mixed with softer varieties, considerable inconvenience being experienced. Black smoke from boilers can often be traced to the presence of hard cannel coal in the fuel used. Much of our present smoke trouble could be minimised if more attention were given to the securing of unmixed supplies of fuel. The micro-examination of a mixed seam, from floor to roof, would tell whether there was a sufficiency of one type of coal to justify separate working.

Though the use of mixed types of coal is to be deprecated when the mixtures are an unknown quantity, a good hard coal can be made to carry a proportion of a softer coal without detriment to its characteristic properties, if carefully and judiciously mixed. Some coking coals will also carry a proportion of a coal of inferior coking properties, or if a good spore coal is used in recovery gas practice a proportion of humic coal can be carried. The high nitrogen content of the latter will increase the ammonia yield.

If the collieries were able to state their types of coal, a purchaser could choose the type most suitable for his needs, or have definite mixtures made. He would require very little other information.

## VII.

## NOTE ON A TREMATODE FROM RAINBOW TROUT.

By W. RUSHTON, A.R.C.Sc., D.I.C., B.Sc., F.L.S.

(Read April 19, 1922.)

TWO TEXT-FIGURES.

DURING the month of July 1921 a report was received from Jersey that an unusual number of rainbow trout, weighing up to a pound in weight, were being found dead on the surface of one of the waterworks reservoirs, and an investigation of some of these dead trout, and careful inspection on the spot, led to the discovery that the gills of most of the dead trout were infected with a trematode worm and the detection in the gut of two species of *Acanthocephalus* worms.

During January 1922 the reservoir was run dry and all the fish netted out, and in many cases where the fish had the appearance of being abnormal it was found that the gills showed the presence of a large number of these trematodes, from 200-300 being taken from one fish. The trematode, or fluke, has not, so far as I am aware, been reported from this area or in England, but occasional epidemics in hatcheries have been reported from America.

The trematode belongs to the genus "*Octocotylidæ*" (Van Benenden and Hesse, 1863), and was identified as *Discotyle sagittatum* Lühe, the old name being *Octobothrium sagittatum*. The characters given for identification are:—

"Elongate; flattened ectoparasitic trematodes. The posterior organ of attachment has, usually in two parallel rows, eight, more rarely four or six, small suckers braced with a characteristic chitinous framework or armed with hooks. Extra hooks often occur on the disc. Genital pore armed with hooks. Eggs supplied with one or two long filaments. Occurring on gills of marine and fresh-water fishes. These parasites are very rare in fresh water. American and European representatives are not well known."

The trematode under examination agrees in all essentials with the above description.

The peculiarity about this trematode is its appearance in an inland reservoir with no outlet to the sea up which migratory fish might find their way, and further the detrimental effect on the fish on which it got a hold. The only way it could have reached the reservoir was by sea birds carrying the eggs on their feet or by the contents of the gut, or by some mollusca acting as a carrier and

finding its way into the reservoir from the land, being carried there in contact with the seaweed used for manuring in Jersey.

The size of the trematode is 5-6 mm. in length and 1-2 mm. wide; it is of a light grey colour and fastens itself between the gill filaments. The shape can be seen from Fig 1, and the style of

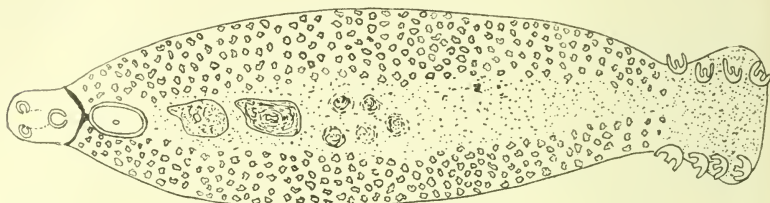


FIG. 1.

hooks on the disc, of which there are eight, from Fig. 2. So far as I am aware a complete life history has not been recorded.

The effect on the fish is very marked. All fish picked up dead or dying and all fish removed by the net when attacked with this

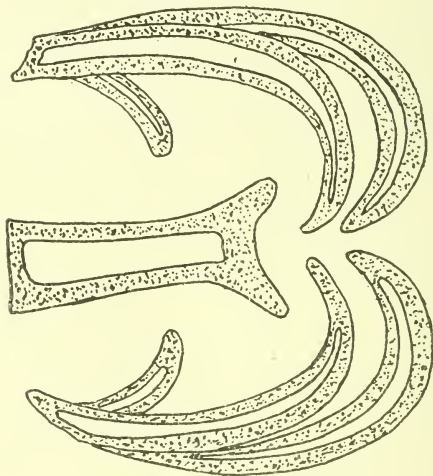


FIG. 2.

parasite show the gills almost bloodless and white; an excess of mucus is exuded which appears to check to some extent the respiratory function of the gills. The fish on the whole shows a poor degree of nourishment, and probably is unable to get rid of the trematode when once badly infected.

In hatcheries it can be removed and the fish improved by the use of a 5 p.c. salt solution, which affects the worm but not the fish, but in a large open water this is impossible. The report from America where epidemics occurred was always from hatcheries, and never from open waters. One report notes the occurrence of this worm from the sucker (*Catostomes teres*).

It is further reported from gills of *Roccus americanus*, which enters fresh water to spawn, so that this parasite may be taken at times in that habitat.

#### CONCLUSIONS.

1. That this trematode acts mechanically at first by stimulating the mucous membrane and causing excessive flow of mucus.
2. Subsequently the gills become bloodless and so the metabolism of the fish is affected.

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## OBITUARY.

SIR GERMAN SIMS WOODHEAD, K.B.E., M.D., LL.D.,  
F.R.S.(Edin.). 1855-1921.

Professor of Pathology, University of Cambridge,  
(President of the Royal Microscopical Society, 1913-14-15).

THE death of Sir German Sims Woodhead, which occurred suddenly at Aisthorpe Hall, Lincolnshire, on Thursday, December 29th, 1921, where he and Lady Woodhead were staying with friends, although not altogether unexpected, came as a shock to the scientific world.

Woodhead was the eldest son of Joseph Woodhead (formerly M.P. for Spen Valley and editor of the "Huddersfield Examiner"), and was born in April 1855. He was educated at Huddersfield College and Edinburgh University. He not only pursued the study of medicine with enthusiasm, but as a member, and later for many years President, of the University of Edinburgh Athletic Club, he found time to devote to sport—in which he made his mark as a sprinter of the front rank and a Rugby international, whilst in later years he was a keen golfer.

He duly graduated M.B., C.M., in 1878, in which year he was the President of the Royal Physical Society of Edinburgh; and three years later his M.D. thesis was awarded a gold medal. The following year he was elected F.R.C.P. of Edinburgh. He then proceeded abroad and pursued his studies for a short period in the Universities of Vienna and Berlin, and also in London. He returned to Edinburgh as Demonstrator of Anatomy and Physiology in an extra-mural school, a post he soon exchanged for that of Demonstrator of Pathology in the University itself, at the same time securing a research scholarship of the Grocers' Company. In 1887 he was appointed Superintendent of the Royal College of Physicians of Edinburgh, a post he held until 1890, when he became the Director of the Laboratories of the Conjoint Board of the Royal Colleges of Physicians and Surgeons in London. Nine years later (1899) he was elected to succeed Professor Kanthack in the Chair of Pathology at Cambridge, a post he held up to the time of his death.

In all three of these appointments it fell to Woodhead's lot to organise and equip the laboratories he was to occupy, and the

buildings at Cambridge will long remain a monument to the care, thought and energy he expended on their development.

He was an ardent volunteer, and became a Captain in the old V.M.S.C. in 1886, and gained his majority in 1902. On the outbreak of war he was mobilized with the R.A.M.C.(T.F.) in the Sanitary Section. In 1915 he was appointed M.O.i/C, the Irish Command Depôt at Tipperary. In 1916 he was gazetted Lt.-Col. and Advisor in Pathology to the War Office, and in 1917 Brevet-Col. A.M.S. and Inspector of Laboratories in Military Hospitals U.K.; and there is no doubt that the continual travelling up and down the country necessitated by this last appointment, with its attendant strain and discomfort, was a material factor in his subsequent breakdown in health. He was thrice mentioned in despatches, and in 1919 received the K.B.E. for special services rendered. He resigned his commission in 1919 on account of ill-health, but retained his rank.

Woodhead was not a prolific writer, but such records of his activities as he has left behind demonstrate to the full that clarity of thought and critical judgment that combined to make him such a successful teacher. Whilst in Edinburgh he published two volumes, one in 1883, "Practical Pathology," profusely illustrated by original drawings (representing actual microscopical preparations), for many of which Woodhead himself was responsible; this manual has passed through four editions, the last appearing in 1910. In 1895, in association with Hare, he published "Pathological Mycology." In 1891 he contributed a volume to the Contemporary Science Series, under the title of "Bacteria and their Products," which remains to this day one of the best popular treatises on these minute organisms. He was Assistant Commissioner to the Royal Commission on Tuberculosis, from 1892 to 1895, and compiled a valuable Report to the Commissioners in 1895; he was also a member of the 1902 Royal Commission on Tuberculosis. In 1893, together with Mr. Pentland, he founded the "Journal of Pathology and Bacteriology"; he continued its editor up to 1920, by which time it had become the official organ of the Pathological Society of Great Britain. In 1894 he published with Dr. Cartwright Wood "An Investigation into the Efficiency of Domestic Water Filters," and there is no doubt that the opinions he formed at this time prompted the chemical experiments he carried out during the early days of the war, which resulted in the standardization of the chlorination process for purifying drinking water for the troops. He was also responsible, in association with the late Mr. Vasey, for the report of the Lancet Commission on the Standardization of Disinfectants (1912), a monumental work of the highest practical importance.

Whilst Director of the Conjoint Laboratories he published a report on diphtheria for the Metropolitan Asylums Board, and

devoted much attention to the standardization of diphtheria anti-toxin; and in 1897 he was awarded the Steward Prize of the British Medical Association.

Tuberculosis was a subject which claimed much of his interest and attention, and his work in connection with the two Royal Commissions has already been referred to. Colonies for the tuberculous also intrigued him, and he was joint author with P. C. Jones Varrier of "Village Settlements for the Tuberculous."

His activities were as varied as they were numerous. He was for many years President of both the British Medical Temperance Association and the British Temperance League, and, although a strong supporter of the temperance movement, was as broad-minded and tolerant in his outlook on the liquor question as he was on every other controversial subject.

He was an Honorary LL.D. of Birmingham and Toronto Universities; F.R.S. Edin.; Fellow of Trinity Hall, Cambridge; Honorary Fellow of the Henry Phipps' Institute, Philadelphia, of the Institute of Sanitary Engineers, and of the Institute of Hygiene; Member of the Executive Committee of the Imperial Cancer Research Fund, an original and subsequently Honorary Member of Medical Research Club; and Member of the Scottish Universities Committee.

Professor Woodhead's association with the Royal Microscopical Society dates from his election as a Fellow in 1911. He joined its Council in 1912, and became its President in 1913. In normal times he would have retired from the Presidential Chair at the beginning of 1915, but as the country was then in a state of war he consented to act for a third year, and there is no doubt that the Society benefited enormously by his comprehensive outlook and sound common sense during these trying early years of the war. His military duties, however, became so exacting that he was compelled to withdraw from any active participation in the Society for some years, but he rejoined the Council after the armistice, and was a Vice-President in 1920; but again the Society was deprived of his valuable services—this time, unhappily, on account of his ill-health.

Whilst the energy and keenness brought to bear upon every aspect of his professional work by Sir German Sims Woodhead compelled admiration, his personal charm attracted all with whom he came into touch. Sympathetic and inspiring, none appealed to him in vain for help or advice, whether upon scientific or purely personal difficulties, and it is difficult to estimate which is the heavier loss to the community at large—that of the keen scientist or of the intensely human man.

Sir German Sims Woodhead married, in 1881, Harriet Elizabeth St. Claire Irskine, second daughter of James Yates of Edinburgh, who survives him.

BENJAMIN MOORE, M.A., D.Sc., F.R.S.

It is with great regret that we have to record the death of Benjamin Moore, F.R.S., Whitley Professor of Biochemistry in the University of Oxford, at the early age of 56; he had made a partial recovery from an attack of influenza, but succumbed from heart failure on March 3rd.

Moore was born and studied in Belfast, and at one time thought of following the profession of engineering, in which he had taken a Bachelor's degree in the Queen's University. He, however, came under the influence of Professor Edmund Letts, of Belfast, of whose teaching he always spoke with enthusiasm. From Belfast he came to University College, London, to study medicine—he did not, however, proceed to his final examinations until many years later, but was for five years assistant to Professor Schafer in the Department of Physiology. During these years he acquired such a reputation, not only in biochemistry but for experimental work, that he was invited to Yale University as Professor of Physiology in the Medical School; a few years later he returned to London to become lecturer in Physiology at the Charing Cross Medical School; about this time he proceeded to the degree of Doctor of Science in his original University.

In 1902 he was appointed to the newly-founded Johnston Chair of Biochemistry at the Liverpool University, the first Chair in that subject to be established in this country. He held this professorship for twelve years, promoting research, and, as Dean of the Medical Faculty, taking an active share in the development of the Medical School during a period of rapid expansion. In 1907 he qualified as M.R.C.S.(Eng.), L.R.C.P.(Lond.), and for a time devoted some attention to medico-political affairs. It was during this time that, in conjunction with Mr. Whitley, he founded the "Biochemical Journal," now the Journal of the Biochemical Society. He was elected F.R.S. in 1912.

Always keenly interested in the problems of public health, Moore relinquished the Liverpool Chair in 1914, and accepted an invitation to join the Department of Applied Physiology under the Medical Research Council. It was in this capacity that he investigated with his accustomed earnestness the problem of trinitro-toluene poisoning, which was causing so much trouble in munition factories. Finding the chief danger was due to the absorption of the material through the skin, he urged precautionary measures which were ultimately adopted. Less than two years ago he was elected to the Chair of Biochemistry at Oxford, then founded by Mr. Arthur Whitley, and became a Fellow of Trinity, the founder's college.

Moore's field of interest in science was very wide—a man of

impetuous imagination, conceiving brilliant ideas and stimulating others by these and by his enthusiasm. During several years he had devoted much time to experimental research in photosynthesis, and we owe to him the first attempts in this country to apply the results of physical chemistry to the intricate problems of biology. Much of the results obtained by him in this line of work is embodied in the book he published last year, "Biochemistry, a Study of the Origin, Reactions and Equilibria of Living Matter." Earlier publications in book form were, "The Dawn of the Health Age," and "The Origin and Nature of Life."

Professor Moore was elected F.R.M.S. in the year 1916, and served on the Council of this Society until he left for Oxford; and on more than one occasion he demonstrated to the Society, in his inimitable style, experiments bearing upon the fascinating problems which engaged his attention.

Sir Edward Sharpey Schafer, Professor of Physiology, Edinburgh, writes, "By his premature death physiology has been deprived of one of its most distinguished exponents, and British physiologists have to deplore the loss of a fellow-worker whose loyalty and modesty of character endeared him to all his friends and not least to myself."

A. W. SHEPPARD.

SUMMARY OF CURRENT RESEARCHES  
RELATING TO  
ZOOLOGY AND BOTANY  
(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),  
MICROSCOPY, ETC.\*

ZOOLOGY.

VERTEBRATA.

a. Embryology, Evolution, Heredity, Reproduction,  
and Allied Subjects.

**Spermatogenesis of Man.**—THEOPHILUS S. PAINTER (*Proc. Amer. Soc. Zool.* in *Anat. Record*, 1922, 23, 129). There are 48 chromosomes in dividing spermatogonia in both the white and negro testes. Two of these 48 chromosomes have no synaptic mates of the same size or shape. These are the X and Y sex-chromosomes. Primary spermatocytes show 24 chromosomes. The X-Y sex-chromosome consists of an element the two halves of which are very unequal in size. When division occurs, the X chromosome goes to one pole, and the Y to the other.  
J. A. T.

**Experiments with Spermatotoxins.**—M. F. GUYER (*Journ. Exper. Zool.*, 1922, 35, 207-23, 1 fig.). Spermatotoxic sera, prepared by injecting fowls repeatedly with the spermatozoa of rabbits, are toxic in vitro for the spermatozoa of both rabbits and guinea-pigs. When introduced into the blood stream of male rabbits at intervals of four or five weeks, such serum produced partial or complete sterility. Inactivation of many spermatozoa, reduction in numbers, or even complete disappearance from the semen, occurred. In one case there were disintegrative changes in the seminiferous tubules. The blood-serum of a rabbit injected intravenously with its own spermatozoa becomes highly toxic for the spermatozoa of rabbits, including its own. The spermatozoa of a rabbit which has been repeatedly injected with its own semen are much less viable, both in normal rabbit serum and in spermatotoxic serum, than are normal spermatozoa. Presumably such

\* The Society does not hold itself responsible for the views of the authors of the papers abstracted. The object of this part of the Journal is to present a summary of the papers as *actually published*, and to describe and illustrate Instruments, Apparatus, etc., which are either new or have not been previously described in this country.

spermatozoa have been influenced specifically in vivo by the spermatoxic serum of their own host. Since an animal can thus on occasion build up antibodies against its own tissues when these have become misplaced or altered, and since antibodies can directly or indirectly affect the germ-cells, it is reasonable to suppose that such influences may be the source of certain germinal variations. J. A. T.

**Vitality of Spermatozoa in Doves.**—OSCAR RIDDLE and ELLINOR H. BEHRE (*Amer. Journ. Physiol.*, 1921, **57**, 228-49). The spermatozoa of ring-doves retained their fertilizing power during nearly eight days. This period represents the interval between the hour of isolation of the male and the hour the egg is laid. No evidence was obtained indicating weakness or modified viability in the embryos obtained from stale sperm fertilizations. Staleness of the spermatozoa did not appreciably affect the sex ratio in the birds studied. J. A. T.

**Spermatogenesis of Lizards.**—THEOPHILUS S. PAINTER (*Journ. Exper. Zool.*, 1921, **34**, 281-328, 4 pls., 6 figs.). Seven species of lizards were studied. In *Anolis carolinensis* there are 12 large V-shaped macrochromosomes and about 22 dot-like microchromosomes in the spermatogonial cells. In the primary spermatocytes there are 6 macrochromosomes and 11 microchromosomes. One of the macrochromosomes is bipartite and passes to one pole of the cell undivided. As a result, the second spermatocytes are of two kinds, part with 5 and part with 6 macrochromosomes. The same holds essentially for *Sceloporus spinosus* and some others. Sex-determination in lizards is of the "double accessory" type; that is, the X-chromosome is derived from two spermatogonial chromosomes. The males are heterozygous as regards sex. A study of ovarian tissue in *Sceloporus spinosus* indicated that the female was of the 2X condition, for two more macrochromosomes were found present than in the males. Dividing somatic cells of embryos show either 12 or 14 V-shaped macrochromosomes, indicating males and females. All the six Iguanids studied show 12 macrochromosomes in the dividing spermatogonia, and in every case at least three pairs of the chromosomes are strikingly alike in size and shape. Syncytial masses and giant spermatozoa are commonly found in the testes of all the lizards studied. J. A. T.

**Complete Hermaphroditism in a Bullfrog.**—WILBERT A. CLEMENS (*Anat. Record*, 1921, **22**, 179-81, 1 fig.). A specimen of *Rana catesbiana* showed the following male characters—a left testis (and doubtless a right testis also, which the student dissector had removed), paired seminal vesicles, paired vocal sacs, paired thumb pads; and the following female characters—paired ovaries with ova and paired oviducts. There would seem to be no doubt, therefore, that this frog had complete and functional paired sets of both male and female reproductive organs. J. A. T.

**Migration of Ear Vesicle in Tadpole.**—GEORGE L. STREETER (*Anat. Record*, 1921, **21**, 115-26, 11 figs.). The developing ear vesicle shifts its position considerably in relation to the brain. The detach-

ment of the vesicle from the skin is due to the differentiation of the subcutaneous tissues and the formation of the pigment membrane. The brain undergoes an eversion which thrusts it ventralward and lateralward toward the vesicle. But there is also a dorsal shifting of the ear vesicle throughout the first month. This may be due to the dorsal portions growing more rapidly than the ventral portions. It looks as if there were some determinative attraction between the endolymphatic sac and the medullary roof to which it invariably becomes intimately attached.

J. A. T.

**Transplanting Part of Neural Tube of Larval Amblystoma.**—H. L. WIEMANN (*Journ. Exper. Zool.*, 1922, **35**, 163–88, 18 figs.). When a small section of the neural tube, at the stage of the closed neural folds, is removed at the level of the second to fourth somites, together with portions of adjacent somites, and re-implanted at right angles to its normal position, the transplanted tube continues its development and retains its original polarity. The growing brain pushes the anterior stump against the anterior side of the transplanted tube, and this may be a factor in forming a union at the point of contact. Nerve fibres grow back from the anterior stump into the transplant; the posterior stump becomes club-shaped, but shows no initial tendency to send out fibres forward into the transplant. A connexion between the transplant and the posterior stump is brought about by the continued growth backward of fibres from the anterior stump through the transplant. Ascending fibres then grow forward from the posterior stump. The transplant eventually becomes absorbed in the reconstructed neural tube, but sections 30 to 40 days after the operation showed that the cells had not lost their original polarity. When the operation is performed at a stage just before the larva becomes sensitive, the process is the same, but the union is more rapid. When the operation is performed at the earlier stages, but in the region of the fifth and sixth somites, or further back, a longer time is required for the formation of nervous connexions: out of twelve operations no case of complete connexion occurred in 30 days; in one case at least the transplant was disintegrated at the end of 30 days.

J. A. T.

**Nerve-Connexions in Transplanted Limbs of Larval Amblystoma.**—S. R. DETWILER (*Journ. Exper. Zool.*, 1922, **35**, 115–61, 32 figs.). Shifting the position of a fore-limb rudiment, a given number of body-segments anterior or posterior to its normal site does not effect to the same extent a corresponding shifting of the segmental nerve contribution to the brachial plexus. There is a marked tendency for transplanted limbs to receive innervation from the normal limb level of the cord. The evidence suggests that there exists between the limb and its normal nerves a developmental relationship which is more intimate in character than that between these same nerves and any other structures. The contention is thus supported that mechanical influences, although governing in large measure the character of nerve pathways, do not reveal how it is that the proper nerve-connexions are made at the periphery.

J. A. T.

## b. Histology.

**Golgi Apparatus and Holmgren's Trophospongium in Nerve-Cells.**—WILDER G. PENFIELD (*Anat. Record*, 1921, **22**, 57-80, 7 figs.). The Golgi apparatus has been described as a cytoplasmic constituent of all types of cells in the animal kingdom; it has been observed developing in the early stages of the embryo; it has been seen to grow and divide with cell-multiplication. In neurones the apparatus reacts to axone section in a specific manner. There is no similar response on the part of Holmgren's trophospongium. The two structures may be demonstrated independently in the cytoplasm of the same neurone, either successively or simultaneously. Occasionally there appears a close anatomical relationship between parts of Golgi's apparatus and Holmgren's trophospongium, which may indicate an intimate association of function. But the two structures are quite distinct. J. A. T.

**So-called Hibernating Gland.**—A. T. RASMUSSEN (*Proc. Amer. Assoc. Anat. in Anat. Record*, 1921, **21**, 78-9). In marmots and the like it is clear that there is no histological resemblance between this structure and the thymus; that there is no evidence of hæmatopoietic function; that it is different from ordinary adipose tissue. The cells are rarely, if ever, unilocular; the nucleus is never flattened much. The organ never loses all its fat. During hibernation it supplies only about one-thirtieth of the material consumed, so it is not an important food-reserve. The cytoplasm of the cell is rich in small granules (in addition to the fat globules), and the organ is surprisingly vascular. The "hibernating gland" remains a riddle. J. A. T.

**Structure of Small Intestine.**—EBEN J. CAREY (*Anat. Record*, 1921, **21**, 189-215, 22 figs.). Because of the left-handed helicoidal arrangements of the musculature of the human intestine, the intestinal movements are comparable to the action of a left-handed screw. The inner muscular layer is wound as a close spiral. The outer is an open spiral. The difference in the rate of translatory progression in the two contraction waves depends upon this muscular arrangement. The wave travelling in the inner group of fibres takes a rotary course, whereas that in the outer fibres takes a more translatory course to reach a corresponding destination. Therefore, the contraction of the stronger inner muscle coat will inevitably trail that of the outer. The arrangement of the intestinal muscle layers clearly explains the phenomenon of cephalic constriction and caudal dilatation of diastalsis without invoking the aid of hypothetical nerve paths. Peristalsis, therefore, is a duplex contraction phenomenon produced by the differential rate of translatory advance of the two contraction waves in the outer and inner muscle layer respectively. J. A. T.

**Origin of Endothelium.**—CHARLES F. W. MCCLURE (*Anat. Record*, 1921, **22**, 219-37). Since endothelium is the essential tissue of the vascular system, the question has naturally arisen as to its origin in development. There are two opposing theories: (a) the angioblast theory of His, that the precociously developed vascular tissue (angioblast) of the yolk-sac grows into the embryonic axis and forms the whole

intra-embryonic endothelium; and (b) the local origin theory, that mesenchyme may, in practically any region of the body, transform into vascular tissue. Morphological evidence favouring the local origin of intra-embryonic endothelium from mesenchyme has been completely confirmed by experiment, and the angioblast theory, in the sense maintained by His, no longer holds.

J. A. T.

**Germ-Centres in Lymphoid Tissue.**—WARO NAKAHARA and JAMES B. MURPHY (*Anat. Record*, 1921, 22, 107-12, 2 figs.). The lymphopoietic function of the spleen and lymph-nodes is a well-known fact, but it is uncertain just how the production of new lymphocytes is brought about in these organs. Flemming first called attention to the frequent occurrence of mitosis in the tissue of lymphoid organs, especially at a certain spot in the follicle, which he called the "germ-centre." This view has been generally adopted. The authors prove it. They describe several kinds of lymphoid reactions in which stimulation of the cell division of the "germ-centres" of lymphoid organs preceded lymphocytosis in the blood. The germ-centres are the birthplaces of blood lymphocytes.

J. A. T.

**Viscosity Changes during Mitosis.**—L. V. HEILBRUNN (*Journ. Exper. Zool.*, 1921, 34, 417-47, 1 chart). The velocity of granular movement under the influence of centrifugal force was taken as a measure of viscosity, and the viscosity of the cytoplasm of the egg of *Cumingia* was determined between fertilization and the first cleavage. In both maturation divisions and cleavage, appearance of the spindle is always preceded by a sharp viscosity increase and followed by a sharp viscosity decrease. At the conclusion of mitosis, within a minute or two before the division of the cell is completed, a sharp increase in viscosity occurs. When two mitoses follow each other, the concluding viscosity increase of the first mitosis becomes the initial viscosity increase of the second. There are similar changes in the egg of *Nereis*, but less marked, this being correlated with the larger size of the *Nereis* egg and the relatively small size of its spindle.

J. A. T.

**Structure of Hypophysis in Urodela.**—WAYNE J. ATWELL (*Anat. Record*, 1921, 22, 373-90, 19 figs.). In tailed amphibians (*Amblystoma*, *Necturus*, *Spelerpes*, *Amphiuma*) the epithelial hypophysis is developed from the ectoderm, and differentiates into three lobes: the pars anterior proprior, the pars intermedia, and the pars tuberalis. The pars anterior proprior, or anterior lobe proper, forms the main bulk of the gland and comes to be caudal and ventral to the infundibulum. The pars intermedia is developed from the dorso-caudal extremity of the early hypophyseal primordium. In its adult position it lies caudal to the neural lobe and dorsal to the anterior lobe. The pars tuberalis develops from a pair of processes which grow forward from the remainder of the gland. These processes do not become detached to form separate epithelial plaques as in the Anura, but maintain their connexions with the anterior lobe throughout life. The neural lobe is considerably sacculated in *Necturus* and *Amphiuma*, and this would of itself suggest that these two forms are primitive, and rather closely related to certain of the fishes.

J. A. T.

**Flagellate Thyroid Cells in Dogfish.**—E. V. COWDRY (*Anat. Record*, 1921, **22**, 289–99, 12 figs.). Each follicular cell in *Mustelus canis* has a large flagellum which extends into the colloid substance. They are well seen by Da Fano's modification of Cajal's silver method, but they may be seen in living thyroid follicles teased out in sea-water. Their presence indicates an interesting combination of motor and secretory functions without apparent adaptive value. It may, however, have some bearing on the problem of the ancestral origin of the gland, e.g. from the flagellated epithelium of a Tunicate endostyle. It also shows that the primary direction of the secretion is towards the follicular lumen, as claimed by Bensley, and not towards the peripheral blood vessels, as suggested by Norris. J. A. T.

**Influence of Inanition on Mitochondria of Gastro-intestinal Epithelium and of Pancreas.**—SHIRLEY P. MILLER (*Anat. Record*, 1922, **23**, 205–10). Experiments on albino rats show that vitamin deficiency and acute starvation may produce changes in the mitochondria in the gastro-intestinal epithelial cells and in the gland cells of the pancreas. Asphyxiation does not apparently produce such marked changes. The amount of injury to the cell must be rather severe to bring about the changes observed. They may involve—(1) a transformation of mitochondria from rod-like to spherical forms; (2) an apparent reduction in the number of the mitochondria; or even (3) the total disappearance of mitochondria from the cells. J. A. T.

**Endings of Cut Nerves.**—SYDNEY M. CONE (*Anat. Record*, 1922, **23**, 185–6, 1 pl.). Cajal has not been able to demonstrate the regeneration of specialized end-organs of sensory nerves, but Cone describes the formation of Pacinian bodies (Vater's corpuscles) in a finger stump. A capsule of vascular connective tissue encapsules the corpuscle. Several capillaries of a fasciculus of nerve fibres pass into corpuscle and spread at the periphery. The nuclei of the Schwann sheath cells become even more than ordinarily elongated and flattened at the circumference, but three or four entire cells are demonstrated in the central core. J. A. T.

**Is Mesenchyme a Syncytium?**—WARREN H. LEWIS (*Anat. Record*, 1922, **23**, 177–84, 4 figs.). Many histologists regard the mesenchyme as a syncytium. They believe that there is actual fusion of process with process, continuity of cytoplasm, and absence of cell boundaries. A study of embryonic chick material of various organs and tissues has led Lewis to the conclusion that embryonic mesenchyme is not syncytial in structure. The evidence from tissue cultures points to the conclusion that it is an adherent reticulum or network. J. A. T.

**Hematomas in Heart Valves of Calves.**—LAURA FLORENCE (*Amer. Journ. Diseases Children*, **23**, 1922, 132–8). Hematomas and hæmorrhages are of frequent occurrence in the atrioventricular valves of human fetuses and of young calves. They occur in the region of attachment of the chordæ tendineæ, and both may occur in the same valve. The hematomas are subcircular cavities lined with a single layer

of endothelial cells, and may be sinusoids which persist from the primary sinusoidal circulation of the heart. The hæmorrhages apparently occur by diapedesis from the vessels of Thebesius. No other pathological conditions were found in the affected valves.

J. A. T.

#### γ. General.

**Parabiosis in Rats.**—NAOHIDE YATSU (*Anat. Record*, 1921, 21, 217–28, 7 figs.). Parabiosis is the term applied to a union of the circulation of two animals; heterosexual parabiosis means the circulatory union of a male and a female. The spermatozoa remain functional; the prostate is not affected; some Graafian follicles are normal, and corpora lutea are formed; a large majority of the follicles undergo regressive changes; the uterus is not markedly changed. When the male is castrated the ovary of the other shows no normal follicles, nor corpora lutea; the uterus is affected. This is probably due to some influence of castration on the endocrine organs of the male. The testis is not affected at all by the union with either spayed or normal female.

J. A. T.

**Catalase Content of Organisms.**—J. H. BODINE (*Journ. Exper. Zool.*, 1921, 34, 143–8, 3 figs.). In grasshopper, firefly, and potato-beetle the catalase content decreases with increasing age and body weight. The rate of  $\text{CO}_2$  output and catalase content seems to vary in the same direction, but in “hibernating” forms a marked decrease in  $\text{CO}_2$  output takes place with no corresponding change in catalase content. Starvation results in decreased amounts of catalase. Further quantitative data regarding catalase content and  $\text{CO}_2$  output are required before any definite relationship between the two can be established.

J. A. T.

**Analogies between Dice-casting and Breeding.**—HARRY M. LAUGHLIN (*Genetics*, 1921, 6, 384–98, 1 fig., 5 tables). The statistical analogy between dice-casting and certain breeding phenomena is in many respects very close. There are, of course, many differences between dice-casting and breeding phenomena, but they have this in common, in both dice-casting and organic reproduction the experimenter is permitted to see, at first, only a single value (the phenotype in life; the upturned face if a die), in a given individual; but if he continues the processes (dice-casting or breeding) long enough, he can test the range of variability possible to the “offspring” of the original “parental” individual. All of the essential phenomena of schemes of selection and the mathematical treatment of their counts may be clearly shown with the dice. The parallel is especially clear-cut if the analogy be to pure lines. The tables show schemes of recording variation, regression and correlation; how selection processes, without creation, secure the highest values potential within a particular line: how for breeding purposes a low value from a good strain is better than a high value from a poor strain; how selection only sorts; and so on.

J. A. T.

**Degeneration of Pelvis in Female Gopher.**—F. L. HISAW (*Proc. Amer. Soc. Zool. in Anat. Record*, 1922, **23**, 108). In mature females of *Geomys bursaria* the pubic bones are completely ossified and there is a pubic symphysis. In both sexes the pelvic girdles are greatly reduced in size—an adaptation to the fossorial habit. But the pubo-ischiatic vacuity is too small for the birth of the young. During the breeding season, however, a degeneration of the pelvis of the young female sets in, beginning in the pubic region and continuing almost to the obturator foramen. After the birth of the young, the symphysis is not re-formed, and virgins may be distinguished in this way from old females. Females which are abnormal in their reproduction or are confined in cages retain the closed symphysis. The degeneration in the pelvis seems to be due to internal secretions of the reproductive system, either before or during pregnancy. J. A. T.

**Hen-Feathering induced in Male Fowls by Feeding Thyroid.**—BENJAMIN HORNING and HARRY BEAL TORREY (*Amer. Soc. Zool. in Anat. Record*, 1922, **23**, 132). Fed daily with thyroid, male Rhode Island Red chicks developed female plumage, although males of this breed do not ordinarily pass through a stage of female plumage. The plumage of capons, usually ultra male, is not affected; nor are castrated females. There seems to be an increase in the activity of the "luteal" interstitial tissue of the testis. J. A. T.

**Photic Reactions of Tadpoles.**—VASIL OBRESHKOV (*Journ. Exper. Zool.*, 1921, **34**, 235-79, 9 figs.). There is an optimum intensity for the responses of *Rana clamitans* tadpoles to light. At and below 0.3 candle-metre intensity, the light ceases to have a physiological effect, regardless of the time of exposure. With effective light intensities below 20 candle-metres, the changes in the receptors during illumination proceed according to the Bunsen-Roscoe law. That is to say, the time required for a given change varied in inverse proportion to the intensity of the light. With intensities higher than 20 candle-metres, a deviation occurs in the intensity-time products, which seem to proceed with a definite constancy. Nearly the whole of the reaction-time in *Rana clamitans* represents a sensitization period. The eyes are not necessary for the responses of tadpoles to light of the kind used in these experiments. Tadpoles subjected to continuous illumination of definite duration become no longer sensitive to light. In the process of fatigue, the reaction-time at any moment has a definite relation to previous illumination. Photosensory recovery after complete exhaustion occurs in the dark in about fifty minutes. J. A. T.

**Penetrative Capacity of Ultra-violet Rays in Frog Embryos.**—W. M. BALDWIN (*Anat. Record*, 1921, **21**, 323-7). Developing embryos were exposed at the time of the closure of the neural tube. Microscopic examination of the sections showed that the ultra-violet light rays produced an injury which was wholly confined to the two-layered ectoderm of the embryo. The underlying mesoderm cells were quite normal. The protecting screen of ectoderm was only about 0.02 mm. thick. A slight increase in the time of exposure or in the

concentration of the rays would have killed the cells. The rayed ectoderm cells multiplied till the ectoderm was thrice the normal thickness, and the amount of pigment was greatly increased throughout, but especially in the deeper layer.

J. A. T.

**Temperature Sense in Frog's Skin.**—ANN HAVEN MORGAN (*Journ. Exper. Zool.*, 1922, **35**, 83-112). The frog's skin contains well-defined receptors for heat and for cold. The heat receptors have a comparatively long reaction time. They are stimulated by 39° C. to 43° C.; the cold receptors at 10° C. This response to cold is immediate and becomes more vigorous as the cold is increased. The typical response to heat is an upward jerk of the leg. The typical response for cold is a rigidity and tenseness of the muscles, but there may be an upward jerk similar to that of the heat response. Responses to heat and cold may be separated from each other and from the tactile and chemical senses.

J. A. T.

**Evolution of Claspers of Elasmobranchs.**—W. HAROLD LEIGH-SHARPE (*Journ. Morphology*, 1922, **36**, 191-8, 5 figs.). Continuation of the author's interesting study of "claspers." The oldest Elasmobranchs (the fossil *Cladoseleache*) have no claspers, and almost certainly no clasper siphons or clasper glands. The next fossils have a direct type of clasper. Possibly the clasper siphons were not yet evolved or were present only in a rudimentary form. Subsequently the scroll type of claspers appeared, suggestive of the Scylliidae. Probably these were accompanied by a clasper siphon. The Lamnidae are geologically more recent than the Scylliidae, and have progressed a stage further and evolved a clasper gland, at any rate in recent forms. Later the skates arrived and resemble those of recent times.

J. A. T.

**Claspers and Associated Structures.**—W. HAROLD LEIGH-SHARPE (*Journ. Morphol.*, 1922, **36**, 199-220, 22 figs.; 221-43, 19 figs.). Comparative studies of the claspers, clasper siphons, and clasper glands in *Chimaera* and *Callorhynchus*, *Torpedo*, *Trygon*, *Spinax*, *Cestracion*, and other types.

J. A. T.

**Growth of Fishes in Relation to Temperature.**—P. AUDIGÉ (*Comptes Rendus Soc. Biol.*, 1921, **84**, 67-9). Observations on *Salmo irideus*, *Salvelinus fontinalis*, *Cyprinus carpio*, *C. auratus*, and *Scardinius erythrophthalmus*, which show a correlation between the temperature of the water and growth. There are optimum temperatures. Increase in size is not uniform, but by fits and starts. The most rapid growth is in spring and in autumn. Reproductive activity is a notable check, and the rate lessens with age.

J. A. T.

**Situs Inversus Viscerum in Double Trout.**—F. H. SWETT (*Anat. Record*, 1921, **22**, 183-99, 6 figs.). In double trout there is often situs inversus viscerum, but the correlation is not precise. The reversal of asymmetry does not seem to be a necessary consequence of the doubling; it may or may not occur, depending on some other factor. Mirrow-imaging only occurs when the digestive tracts are fused at some point between the pylorus and the exit of the intestine from the

abdominal cavity. There is no accurate correspondence between the degree of external and internal budding. Situs inversus viscerum remains a puzzle. J. A. T.

**Fecundity of Top-Minnow.**—R. L. BARNEY and B. J. ANSON, *Anat. Record*, 1921, **22**, 317–35, 2 pls., 3 figs.) The American viviparous top-minnow, *Gambusia affinis*, is of much importance as a mosquito-destroyer. A study of its reproduction is interesting. There is a tissue investing the ovary and a definite genital duct. The ova that appear subsequently as liberated young are all fertilized at once. As the fishes increase in size, their fecundity increases. It appears that 80 p.c. of the annual production of young occurs before there is any considerable decline in the temperature of the water. But besides temperature there is an internal factor: the egg-production is influenced by the size and metabolic potentialities of the female for that season. J. A. T.

#### Tunicata.

**Reactions to Light in Larvæ Amaroucium.**—S. O. MAST (*Journ. Exper. Zool.*, **34**, 149–87, 10 figs.). The tadpole-like larvæ have a single eye, seated laterally at the posterior end of the body near the base of the tail. It has a lens, a pigment cup, and optic nerve-endings. When the larvæ emerge from the colony they are for a short time strongly photo-positive; after a few moments they become photo-negative, and remain so until they become attached. They rotate rapidly and continuously on their longitudinal axis. If the light is rapidly reduced the resting specimens become active, and the active specimens change their direction, the positive ones turning towards the abocular and the negative ones towards the ocular side. Increase of illumination does not affect resting specimens; but negative active specimens turn toward the abocular side. The reaction time is so short that if the hand is moved up and down in front of the microscope as rapidly as possible, alternately increasing and decreasing the luminous intensity, the tail in attached specimens swings from side to side in harmony with the movement of the hand. Gradual changes in illumination have no effect. The photic reactions probably depend on the illumination of the nerve-endings. Orientation is the result of one or more shock reactions caused by the alternate shading and illumination of the optic nerve-endings, owing to rotation on the longitudinal axis. After the tadpoles are oriented, the retina is continuously approximately equally illumined; the shock reactions cease; the tadpoles continue on the course established. In this organism orientation is in no way dependent upon a balanced effect of stimuli acting continuously on symmetrically located photoreceptors, as suggested by the Decandolle-Verworn theory of orientation accepted by Loeb and others. J. A. T.

**De-differentiation in Perophora.**—JULIAN S. HUXLEY (*Quart. Journ. Micr. Sci.*, 1921, **65**, 643–97, 3 pls., 1 fig.). The social Ascidian *Perophora viridis* may de-differentiate in either of two distinct ways, or by a mixed method: (a) by reduction to a spheroidal mass, as in

*Clavellina*; (b) by incipient reduction as in (a), but followed by total resorption into the stolon, which may grow during the process. Resorption is due to the migration of the individual cells out of the tissues into the hæmocoel. In certain conditions the zooid maintains itself, in spite of food not being provided, at its original size and in perfect health. This it does by resorbing the stolon. This happens in slightly unfavourable conditions, which affect the sensitive zooid more than the less highly organized stolon. The stolon tends to be starved at the expense of the zooid. The zooid is more susceptible to toxic agencies. In low concentrations of toxic agencies it is therefore affected, while the stolon is not. As a result it begins to de-differentiate, and cells migrate out of the tissues. The speed of the zooid's metabolic processes is no longer greater than that of the stolon's. It is therefore starved at the expense of the stolon. Any cells migrating out of the tissues are removed by the normal circulation, by the stolon-circulation (irregular pulsation of the stolon), or by utilization as food by the stolon. As in chemical reactions where the end-products are removed, the reaction thus runs to its limit, i.e. to complete resorption of the zooid. Stopping the circulation by KCl lessens the degree of resorption. At low temperatures (about 5° C.) there is some de-differentiation, but very little resorption. The general biological aspects of de-differentiation are discussed.

J. A. T.

**New Styelid Tunicate from Norway.**—AUGUSTA ÅRNBÄCK-CHRISTIE-LINDE (*Bergens Mus. Aarbok.*, 1921, 20, No. 3, 1-8, 1 pl.). A description of *Styela theeli* sp. n., from Hardanger. It agrees in some external and internal features with the members of the group *Goniocarpa*, but it has two gonads on one side and one gonad on the other, whereas in the *Goniocarpa* group there is one on each side. In the *canopus* group there are two on each side, so that *S. theeli* is in this respect intermediate. The single specimen was dredged along with *S. loveni* and *S. rustica*, but it seems to be quite distinct from any known species of the genus.

J. A. T.

**Parallelism in Ascidians.**—A. G. HUNTSMAN (*Proc. Amer. Soc. Zool. in Anat. Record*, 1922, 23, 92-3). Ascidians in general and Styelidae in particular offer very good illustration of parallelism in the evolution of body-form. In Styelidae the outstanding fact is the repeated appearance of a peculiar stalked type in distinct genera. It is suggested that the lines are limited, not by selection, but by the structure of the ancestral germ-plasm. There are internal architectonic conditions depending ultimately on the structure of the living matter.

J. A. T.

## INVERTEBRATA.

### Mollusca.

#### γ. Gastropoda.

**Effect of Ultra-violet Rays on Developing Limnæus.**—C. W. M. POYNTER (*Proc. Amer. Ass. Anat. in Anat. Record*, 1922, 23, 32-3). Lethal and monstrous effects are readily produced, but embryos are

more sensitive to the rays at some periods of development than they are at others. A comparison of short non-lethal exposures with continuous cytolyzing doses suggests that one of the effects of the light is to form a phototoxic substance which is cumulative in its effects. The effect of the rays in small doses is frequently spoken of as stimulating, but the experiments on *Limnæus* show that the stimulus is katabolic in character. There is not the same recovery curve as in *Paramacium*. J. A. T.

**Phototropism of Land Snails.**—G. C. WHEELER (*Comparative Psychology*, 1921, 1, 149-54, 1 fig.). Experiments show that *Helix aspersa* is negatively phototropic, at least at certain intensities of light. The photo-receptors are in the eyes at the ends of the dorsal tentacles. The snails are not dermatoptic. The eyes are sensitive only to light falling in a particular direction on the ends of the tentacles. The eyes probably function as direction-eyes only. Yung's experiments, which led him to regard the eyes as functionless, do not prove more than that the eyes are of no special value as image-forming eyes. J. A. T.

### Arthropoda.

#### a. Insecta.

**Mutations in Bar-eye Series of *Drosophila melanogaster*.**—CHARLES ZELENY (*Journ. Exper. Zool.*, 1921, 34, 203-33, 5 figs.). A bar is a constriction of the full eye, and ultra-bar is a separation into two parts. There are three definite stopping-places without intermediates. All possible jumps between these stopping-places have been seen except full to ultra-bar. Reverse mutations are more frequent than the original direct ones. Full derived by mutation from bar or ultra-bar does not revert. There is no evidence of periodicity in the mutations. They occur in the germ-plasms of both sexes. They are not confined to a single period in the germ-cell history. The changes in the gene which produce the somatic series full to bar to ultra-bar are probably not of a quantitative nature. The different components of the bar series are definite entities comparable to definite chemical compounds or physical states. J. A. T.

**Protection against Blowflies.**—R. A. WARDLE (*Ann. Applied Biology*, 1921, 8, 1-9). An account of numerous experiments in saving meat commodities from blowflies. There are a few repellent substances of some value that can be applied to the meat, e.g. a proprietary article called "Milton." Pepper, powdered chalk, and powdered boracic acid are of use as long as they remain dry. Other substances which cannot be directly applied may be useful repellents, e.g. for a short time, eucalyptus oil, formic acid, and sometimes clove oil. The most effective oil repellent seems to be oil of aniseed smeared on to cotton netting. J. A. T.

**Beetles and Bugs in *Tachigalia petioles*.**—W. M. WHEELER (*Zoologica*, 1921, 3, 35-126, 5 pls.). The swollen petioles of this Leguminous tree are entered, in the young shade forms, by beetles

(*Coccidiotrophus socialis*) which excavate the loose pith or clean things up if there have been previous tenants. The females lay eggs; the larvæ and adults feed on the growing parenchyma. But the beetles bring in female mealy-bugs (*Pseudococcus bromeliæ*), which suck the plant juices; and both larval and adult beetles massage the bugs for the sake of drops of honey-dew. There is an intimate biocenose. The collaboration may be disturbed by the thief-ants (*Solenopsis altinodis*) and other intruders. When the young tree ceases to be a shade plant, ants (*Azteca* and *Pseudomyrma*) take up their abode in the petiole, also keeping partner Coccids, and the beetles are only found on the young trees. There is another beetle, *Eunausebius*, which behaves in the same way as *Coccidiotrophus*, but it is much less vigorous and seems like a feeble, anæmic, and harried species. An account is given of other "social" beetles, and the significance of the remarkable co-operation is discussed in its ecological and psychological aspects.

J. A. T.

**Tachigalia Ants.**—W. M. WHEELER (*Zoologica*, 1921, 3, 137-68). Two species of *Pseudomyrma* and two of *Azteca* are definitely attached to *Tachigalia* as host-tree. The recently fertilized queens of these ants perforate and enter the petioles of young *Tachigalias*, close the openings behind them, and produce their broods. All the petioles of the larger trees are invariably inhabited by a single flourishing colony of one species only. No sooner are the petioles opened by the young broods of workers than the Coccids (*Pseudococcus bromeliæ*) enter or are carried in by the ants and attach themselves to the areas of nutritive parenchyma within the petioles. They are cared for by the ants and "milked." But there are many other ants on the *Tachigalia*-tree, and a descriptive list of twenty-eight is given. The thief-ants and the leaf-cutters militate against the biocenose.

J. A. T.

**Variation in Mealworm.**—S. A. ARENDSSEN HEIN (*Journ. Genetics*, 1920, 10, 227-64). In most populations of larvæ bought in the trade, two colour-varieties are found—chestnut-brown (CB) and orange-red (OR), and occasionally a type with black abdomen (BA). The most frequent larval anomalies exhibit themselves as a development of the rudimentary wings, as a partial fusion of the segments, and as a variation in the number and position of the spines occurring on the last segment. The male and female pupæ are easily distinguished. The sex ratio may be taken as equal. In the adults there are size differences, sex differences, differences in egg-production (359 the maximum obtained), in the duration of egg-production (normally two months). The female survives the male by about fifty-one days; the male may mate with several females. The yellow and red colour of the eyes and some forms of reduction in the number of tarsal and antennal segments are based on hereditary factors. The yellow eye-colour has a sex-limited descent, but the red appears to be not sex-limited.

J. A. T.

**Blue-green Caterpillars as a Mutation.**—JOHN H. GEROULD (*Journ. Exper. Zool.*, 1921, 34, 335-416, 6 figs.). In a closely inbred stock of protectively-coloured grass-green caterpillars of *Colias philodice* there appeared numerous conspicuous blue-green forms. The three broods in which they first appeared showed the 3:1 ratio, grass-green

being dominant. The mutation can be traced back to a single individual—a heterozygous grass-green great-grandparent. The Mendelian factor for blue-green existed unsuspected in the true-breeding wild stock, but was brought to light by inbreeding. The offspring of two recessives (blue-green) bred true. The mutation is not sex-limited. Two non-inherited pigments—xanthophyll and chorophyll—derived from the food-plant form the basis of the dominant and recessive colours. Both probably exist together in normal grass-green hæmolymph. The hereditary nuclear enzyme, or recessive gene, involved in this case is a decolorizer (inhibitor) of xanthophyll. Since it is recessive it must be present in double dose (homozygous condition) in order to produce its effect. The wing-colour of the adult is not affected, but the eye-colour is—probably through some action of the blood. The egg and the pupal cuticula are also affected indirectly like the eye, and the blood also affects the colour of the cocoons spun by Hymenopterous parasites (*Apanteles flaviconchæ*) emerging from the blue-green caterpillar, for the silk is white instead of golden-yellow. The blue-green mutants are as vigorous and disease-resistant as the grass-green types; but the adults are less active and less inclined to mate. The blue-green caterpillars are eliminated by sparrows; the grass-green types are protected.

J. A. T.

**Factors in Appearance of Winged and Sexual Aphides.**—J. DAVIDSON (*Sci. Proc. R. Dublin Soc.*, 1921, 16, 304–22). The early aphidologists considered that food and temperature were the important factors influencing the apterous and winged forms in Aphides. From cytological investigations and recent breeding experiments it appears highly probable that the sequence of winged and apterous forms is largely due to some internal inherent tendency. Winged viviparous females tend to produce apterous viviparous females, and apterous viviparous females tend to produce either apterous viviparous females or a mixed progeny, including a very variable percentage of winged forms. The apterous condition is to be regarded as an adaptation to seasonal food and temperature conditions. Similarly, food and temperature were regarded as the important factors affecting the development of sexual forms. But later cytological investigations show that the appearance of the sexual forms is associated with changes in the chromosome complex. The agamic generations appear to be interpolated between the winter egg and the sexual generation as adaptations to seasonal conditions. The approach of winter conditions would normally be the factor affecting the bringing to an end of the parthenogenetic phase and the appearance of the sexual forms. In some cases the production of the sexual forms may be superseded by continued parthenogenetic reproduction, certain agamic forms either reproducing slowly throughout a mild winter, or lying dormant and continuing reproduction the following season. In isolated cases, certain agamic individuals may be affected physiologically by some factor or factors, so that they do not respond to the inherent stimulus to develop into sexual forms. These individuals would normally die in winter, but under favourable conditions they may continue agamic reproduction.

J. A. T.

## 8. Arachnida.

**Adaptive Modification of Spider's Web.**—HENRY E. CRAMPTON (*Proc. Amer. Soc. Zool. in Anat. Record*, 1922, **23**, 130). Along the railroad through the jungles of southern Siam, the telegraph wires provide spaces of varying width which are used as a basis for the webs of Argiopid spiders, probably of the genus *Nephila*. Full-sized webs are made where the intervals are suitable. Where the interspaces are less than the diameter of a normal web, the spiders modify the structures by omitting an upper sector of greater or less extent, making an effective adjustment.

J. A. T.

## 9. Crustacea.

**Nutrition in Phyllopods.**—O. LUNDBLAD (*Arkiv. f. Zool.*, 1921, **13**, No. 16, 1-114, 1 pl., 7 figs.). A detailed study of the modes of feeding in Phyllopod types. The genus *Tanymastix* is a typical plankton-feeder; *Limnadia* is a mud-eater; *Lepidurus* is mainly carnivorous, but to a slight extent a mud-eater. There are adaptations to these different modes, but the mouth-parts are all referable to the same general type. The bending down of the head against the ventral surface of the body is characteristic. The spines and setæ of the endites of the appendages and of the ventral groove are functionally important.

J. A. T.

## Annulata.

**Earthworm's Reactions to Light.**—WALTER N. HESS (*Proc. Amer. Soc. Zool. in Anat. Record*, 1922, **23**, 122-3). Earthworms, which are negative to light of ordinary intensity, become positive, in keeping with their nocturnal habits, when the light is greatly diminished. If, however, the brain is removed either by a dorsal incision or by the removal of the first three anterior segments, they no longer react negatively to ordinary illumination, but become strongly positive. If six or more of the anterior segments of *Lumbricus terrestris* are removed, the worms are still positive. Similar results were obtained with *Allolobophora fatida* when as many as forty anterior segments were removed. These results show that the brain of the earthworm is not necessary for reactions to light and photic orientation. They indicate that earthworms are more sensitive to light when the brain and the photo-receptors at the anterior end are functional, than they are when these structures are not functional. This accounts for the fact that, while normal worms are positive only in very weak light, specimens with the brain removed are positive in strong light.

J. A. T.

**Bifurcation in Embryos of Tubifex.**—PAUL S. WELCH (*Biol. Bulletin*, 1921, **41**, 188-201). Bifurcation is frequent and varied in embryos of *Tubifex tubifex*. In each cocoon there are 1-17 ova. The emergence of the young worms is through two opposite apertures. Approximately 20 p.c. of the cocoons contained bifurcate embryos. Both ends of the body may be affected, in simple or compound form. In more than 4,000 recently emerged worms only 10 bifid forms were found. Any departure from normal body form involving increase in

diameter constitutes an extremely effective barrier to escape from the cocoon. Practically all of the numerous abnormalities are automatically eliminated. While bifid worms may live for a long time imprisoned within the cocoon, emergence is a rarity. Attempts to rear bifid individuals were unsuccessful. No bifid forms were found in natural conditions. A preliminary study, especially as regards the setæ, the nervous system, the nephridia, and the circulatory system, shows the body region of the monster-embryos to be double in composition, while the bifurcate portions simulate the normal *Tubifex* structure. J. A. T.

**Epithetosoma not a Gephyrean but a Nemertine.**—SIXTEN BOCK (*Bergens Mus. Aarbok*, 1921, 20, No. 9, 1-6). A section through the type-specimen of *Epithetosoma norvegicum* Dan. and Kor. proves that the animal is a Heteronemertine, as Théel previously suggested. The specimen is badly preserved, but it is a Lineid, probably in the genus *Micrura*. In any case it has nothing to do with Gephyrea, and the genus *Epithetosoma* must be dropped. J. A. T.

#### Nematohelminthes.

**Spermatogenesis of *Ascaris felis*.**—A. C. WALTON (*Journ. Exper. Zool.*, 1921, 34, 189-201, 2 pls.). This Nematode shows nine chromosomes for the haploid number, eight tetrad autosomes, and one hexad heterochromosome. This heterochromosome consists of an idiosome attached to the end of an autosome. This union occurs in the primary spermatocytes, the idiosome being a separate chromatic entity during the spermatogonial developmental period. The idiosome is of the X-type, undergoing quantitative division at the time of the formation of the spermatids. J. A. T.

**New Nematode Infection in Man.**—C. A. KOFOID and A. W. WHITE (*Journ. Amer. Med. Assoc.*, 1919, 72, 567-9). Report of Nematode ova, the largest encountered in many human stools (95 by 40 microns), and marked by a broad concavity on one face and by two highly refractive, hyaline, bluish-green globules, flattened asymmetrically at the two poles of the embryo, which are dispersed as development proceeds. The ova are very distinctive, and are referred provisionally to *Oxyuris incognita* sp. n., pending the discovery of the adult stage. It may be that the ova, which occur in soldiers from many parts of the United States, come from a small species of *Oxyuris* which is beginning to attack man, perhaps in the appendix and the ducts of the liver. J. A. T.

**Blood Filaria of Goliath Heron.**—F. NOC (*Comptes Rendus Soc. Biol.*, 1921, 84, 69-71). In the right auricle, pulmonary veins, and superior vena cava of *Ardea goliath* from Dakar there were abundant specimens of a new species of Filaria. The colour is opal-white. The habits of the adults and embryos are rather sluggish. The liberated embryos are surrounded by a sheath which is due to an elongation of the shell. The worms ingest the host's blood. No hint of the intermediate host was discovered. J. A. T.

## Rotatoria.

**Constancy of Nuclei in *Hydatina senta*.**—H. J. VAN CLEAVE (*Proc. Amer. Soc. Zool.*, 1922, **23**, 102). In 1912 Martini maintained that each individual of *Hydatina senta* has a fixed total of 959 nuclei. In 245 vitellaria Shull found (1918) 4 p.c. which did not show the customary eight nuclei, and some other discrepancies were observed. The author examined 435 gastric glands without discovering a single departure from the customary six nuclei. In 770 vitellaria only three<sup>a</sup> were found with supernumerary nuclei, two with ten, and one with twelve, instead of the normal eight. It may be said that there is almost absolute constancy in the nuclear numbers in this form.

J. A. T.

**Experimental Study of a Rotifer.**—BESSIE NOYES (*Journ. Exper. Zool.*, 1922, **35**, 225–55). An account of normal life-cycle of *Proales decipiens* and of the results of experiments. The animal lives about a week, and then dies with characteristic symptoms of senility. During its life it produces several eggs per day, the number increasing to a maximum, then decreasing with the onset of old age. Reproduction by parthenogenesis for about 250 generations gave no indication of reduction of vigour in the race in any respect. During this period no males appeared. Environmental changes of various kinds failed to evoke males. So far as is known, the species may be quite without males. An attempt to increase the egg deposit and average length of life through artificial selection carried on for three months, in 15 generations, was without avail, placing this organism in the list with other parthenogenetic forms in which selection is ineffective. Treatment with ethyl alcohol in a concentration of  $\frac{1}{4}$  and  $\frac{1}{2}$  p.c. for twenty weeks reduced the number of eggs produced from an average of 15 to 24 in normal malted milk to an average of 10 to 14 in  $\frac{1}{4}$  p.c. alcohol, and 3 to 5 in  $\frac{1}{2}$  p.c. alcohol, although the length of life was little influenced. The reduction in egg deposit brought about by alcohol was not retained beyond the third generation of descendants restored to normal conditions of culture.

J. A. T.

## Echinoderma.

**Amœbocytes of Holothurians.**—HJALMAR THEEL (*Arkiv. f. Zool.* 1921, **13**, No. 25, 1–40, 7 pls., 7 figs.). A study of hyaline plasma-amœbocytes, bladder amœbocytes, spherule-containing amœbocytes, and crystal-containing amœbocytes in species of *Cucumaria*, *Thyone*, *Psolus*, *Stichopus*, and other genera. The bladder-cells seem to have escaped previous investigators. The bladders do not change their position within the cell; they may be bent on themselves and lie in three planes. The crystals or spicules are formed as vital products within the amœbocytes. The skeleton of Echinoderms is due to the migration and syncytial fusion of calciferous amœbocytes. Different cells form different spicules in the same animal and apparently in the same conditions.

J. A. T.

## Cœlentera.

**New Alcyonium from Annam.**—SYDNEY J. HICKSON (*Bull. Soc. Zool. France*, 1919, **44**, 411). Description of *Alcyonium krempfi* sp. n., a brown encrusting colony, with mamilla-like lobes, with spicules in the coenenchyma and in the anthocodia in the form of double asters 0.1 mm. in length.

J. A. T.

**Alcyonaria in Cambridge Museum.**—SYDNEY J. HICKSON (*Proc. Cambridge Phil. Soc.*, 1921, **20**, 366-73, 1 fig.). Descriptions of some interesting specimens:—*Clavularia dura* sp. n., from off Adelaide, with the walls of the stolon and calices extremely hard; *Surcodictyon catenata* Forbes, a form hitherto recorded from the British area only, now from off Adelaide; *Pseudocladochonus hicksoni* Verslujs, from near Tokyo, previously recorded from the Moluccas, a very remarkable Telestid; *Leptogorgia* sp., a specimen collected by Darwin in 1835; *Cavernularia chuni* Kükenthal and Broch, washed ashore at Sarawak; and *Cavernularia darwini* sp. n., from Darwin's "Beagle" collection, with characteristic rachis spicules like mammalian metacarpal bones.

J. A. T.

**Secondary Sex Characters in Plumularids.**—M. BEDOT (*Revue Suisse Zool.*, 1922, **29**, 147-66). In some Plumularids there is a transformation of hydroclads into phylactocarps, believed to protect the gonangia. Bedot discusses these in various types and shows that in many cases their protective rôle is dubious or unreal. He proposes to substitute for the word phylactocarps the word metaclad. He regards them as secondary sex characters in some species of *Aglaophenia* and *Thecocarpus*. In other words they are transformed hydroclads, showing sex dimorphism, but having no definite function.

J. A. T.

## Protozoa.

**Chemical Composition of Spore-envelope in Nosema apis.**—ADRIENNE KOEHLER (*Zool. Anzeig.*, 1921, **53**, 85-7). Hitherto there has been no definite information in regard to the nature of the shell or envelope of the spore in this parasite of the bee. Very little is known indeed of the nature of the spore-envelope in general. By careful technique it has been found possible to prove that the component substance is chitin.

J. A. T.

**New Gregarine in Sand-hopper.**—R. POISSON (*Comptes Rendus Soc. Biol.*, 1920, **53**, 1396-8). A description of *Cephaloidophora brasili* sp. n. from the alimentary canal of *Orchestia littorea*, which also contains *Didymophyes longissima*. The new form is intracellular to begin with, in the cells of the midgut epithelium. It becomes free in the lumen, singly or in syzygous couples. There are occasionally chains of three or four.

J. A. T.

**New Ciliate in Larvæ of Stegomyia.**—D. KEILIN (*Parasitology*, 1921, **13**, 216-24, 6 figs.). A description of *Lambornella stegomyiæ* g. et sp. n., which seems to be the first recorded instance of a Ciliate parasitic

in the cavity of the body in an insect. It is a holotrichous parasite, densely ciliated, with micronucleus lying in a depression of the macronucleus, with granular protoplasm containing few basophil vacuoles. The multiplication is effected by simple transverse fission into two equal parts. There are hemispherical cysts, transparent and structureless, attached to the host's cuticle, e.g. on the "gills." The description is based on material collected by Dr. W. A. Lamborn in the Federated Malay States.

J. A. T.

**Infusoria from Calcutta.**—EKENDRANATH GHOSH (*Bull. Carmichael Medical College Belgachia*, 1921, 2, 6-17, 1 pl.). Records and descriptions of new species of *Anoplophrya*, *Lionotus*, *Chlamydodontopsis*, *Orthodon*, *Stegochilum*, *Nyctotherus*, *Parabursaria*, *Balantidiopsis*, *Balantidium* and *Stentor*.

J. A. T.

**Trichomonas augusta.**—ISAAC OCHOTERENA (*Revista Mexicana Biología*, 1921, 1, 267-73, 7 figs.). Description of this species found in the rectum of many species of frogs. Reproduction is effected by karyokinetic division during phases of amoeboid activity. The nuclear membrane remains intact, and there is finally a median strangulation suggestive of amitotic division in Metazoa.

J. A. T.

**Movement of Vorticella.**—J. BELEHRADEK (*Comptes Rendus Soc. Biol.*, 1920, 83, 1362-3). The stalk of Vorticella consists of the myoneme and its enveloping sheath. It is often regarded as a prototype of a muscle-fibre, but it is a transformed flagellum. Its movements do not consist of a shortening and elongation of the myoneme, but of a brusque spiral rotation, in the course of which the body of the animal likewise rotates.

J. A. T.

**Infection of Chimpanzee with Malaria.**—F. MESNIL and E. ROUBAUD (*Ann. Inst. Pasteur*, 1920, 34, 466-80, 1 pl.). A female chimpanzee kept for several years at the Pasteur Institute had a short but unmistakable attack of tertian malaria after an intravenous injection with *Plasmodium vivax*, but re-inoculation twenty days after the disappearance of the parasite had no result. A young male, recently imported, was similarly inoculated, but without infection. When human blood with crescents only or with crescents and young schizonts was injected there was no infection. The persistence of the crescents in the circulating blood was observed for three days. Both chimpanzees were bitten by mosquitoes containing *Plasmodium præcox*, but nothing happened. For the first time—namely, in the case first mentioned—human tertian malaria has been observed in an animal. The chimpanzee is at the limit of resistance to a disease hitherto regarded as strictly peculiar to man.

J. A. T.

**Generative Protoplasm in Gregarina cuneata.**—B. D. MILOJEVIC (*Comptes Rendus Soc. Biol.*, 1921, 84, 99-100, 1 fig.). Immediately after encystation the two primary nuclei undergo characteristic changes: the karyosome becomes pale, losing most of its chromatin, and the volume of the nucleus increases. Around it there appears an irregular zone of hyaline and very dense protoplasm—the generative protoplasm.

It is clear without any staining or fixing. It arises by a sort of condensation of the protoplasm within the cyst, by a coalescence of alveolar walls and disappearance of spaces and inclusions. Meanwhile in the disintegrating karyosome the first generative nucleus appears: it passes out of the primary nucleus into the generative protoplasm. The latter becomes peripheral within the cyst, forming a hyaline layer, and this fragments into as many portions as there are generative nuclei (derived from the first by mitosis). Thus the gametes are formed. The author points out that there is here a clear case of the protoplasm playing an important rôle in heredity as well as the chromatin of the nucleus.

J. A. T.

**Intestinal Parasites observed in Malta.**—THOMAS BENTHAM (*Parasitology*, 1920, 12, 72–82). Observations made by the late Lieut. T. Bentham on 3370 cases among troops and prisoners in Malta. The parasites included *Entamæba histolytica*, free Amœbæ (not determined), other Protozoa, *Tænia saginata*, *T. solium*, *Hymenolepis nana*, *Clonorchis sinensis*, *Schistosomum hæmatobium*, *S. japonicum*, *Fasciola hepatica*, *Trichuris trichiura*, *Ascaris lumbricoides*, *Strongyloides stercoralis*, *Ankylostoma duodenale*.

J. A. T.

**Choice of Food in Amœba.**—ASA A. SCHAEFFER (*Journ. Animal Behaviour*, 1917, 7, 220–58). Amœba is capable of nice discrimination between two particles of different composition—one digestible, the other not—lying very close together. When the particles stick together slightly, the food cup in some way separates them so that the food particle comes to lie inside the cup, while the other is actively pushed to the outside. The amœba not only expresses choice between particles of different composition, but if the conditions are such that a choice cannot be made at once, the amœba can change the conditions (separate the particles) so that a choice may be made. No definite statement can be made regarding the basis upon which choice in general is made, for some digestible substances are refused (zein, gelatin) and some indigestible substances (carmine, indian ink) are readily eaten. It can be stated, however, that the basis of selection is not chemical in any known case, and that in several important cases selection is based upon physical properties.

Movement of a particle is an important quality. Particles of glass, which are never eaten when lying still, are readily eaten when agitated. The ingestion-value and the digestion-value are very different. Observation and experiment indicate that amœbæ might possibly be able to exist and propagate indefinitely in nature if they selected their food on the basis of movement alone. Experiments show that, in many cases, past experience in receiving stimuli or in feeding is of more importance in selection than the nature of the stimuli received from a present object. Many individual acts of food-selection cannot be explained when standing alone, but they are explicable when the amœba's past, especially its immediate past, is known. Food-selection is therefore an historical process. There is a physical factor in food-selection; there is also an experimental factor.

J. A. T.

**Studies on Chrysomonads.**—W. CONRAD (*Bull. Acad. Roy. Belgique, Classe des Sciences*, 1920, 167–89, 11 figs.). A description of *Synura uvella* Ehr. and the colony it forms; of *Thallocrysis pascheri* g. et sp. n., which occurs in isolated unicellular form or as pleurococcoid aggregates; and of *Chrysopsis sphagnorum* sp. n., which lives inside the cells of Sphagnum, and has a peculiar watch-glass shaped chromatophore.

J. A. T.

**Comparison of Amœbæ and Tissue-culture Cells.**—MARY JANE HOGUE (*Journ. Exper. Zool.*, 1922, 35, 1–11, 3 figs.). Comparison of *Vahlkampfia patuxent*, an amœba parasitic in the food-canal of the oyster, with fibroblasts and leucocytes. The amœbæ move much more quickly than the fibroblasts; the amœbæ were much better able to deal with bacteria. The reactions to stains were different. There are differences in the mitochondria and in the taking in of melanin granules. Ordinarily when the nucleus and cytoplasm of a tissue-culture cell have taken methylene-blue or brilliant cresyl-blue or neutral-red stain the cell is said to be dead. Again, in tissue-culture cells, when the colour of the neutral-red granules fades and they become clear, the cell is thought to be dead. With the amœba a different standard must be used. For the amœba goes on moving actively after the staining of the cytoplasm and nucleus. As they die there is a gradually slowing of the movement and in the forming of pseudopodia.

J. A. T.

**Intestinal Protozoa of Japanese Termites.**—MAKOTO KOIDZUMI (*Parasitology*, 1921, 13, 235–309, 6 pls., 5 figs.). Three genera are recognized in the *Trichonympha* series and *Trichonympha* group—large complicated forms with numerous flagella—namely, *Trichonympha* Leidy, *Pseudotriconympha* Grassi, *Teratonympha* g. n. (with numerous transverse ridges suggesting a Cestode!). Four genera are recognized in the *Trichonympha* series but *Holomastigotoides* group—less complicated forms with flagella arising in rows, which have a common point of origin at the anterior end and wind spirally backwards—namely, *Microspironympha* g. n. (with a tubular structure connecting the anterior tip of the body and the nucleus), *Holomastigotoides* Grassi, *Spirotrichonympha* Grassi, and *Holomastigotes* Grassi. Then there is the *Pyrsonympha* series with an axial filament fixed anteriorly and running down the body, and with four or eight slender cords starting at the tip of the filament and running spirally backwards, fixed on the body wall, to the posterior extremity, where they emerge as free flagella. The author makes a comparative study of these extraordinary Protozoa. J. A. T.

**Structure and Life-history of Paramœcium calkinsi sp. n.**—LORANDE LOSS WOODRUFF (*Biol. Bull.*, 1921, 41, 171–80). This new species has been studied in pedigree cultures for more than a year. It presents an interesting composite picture of *P. aurelia*, *P. bursaria*, *P. putrinum*, and *P. trichium*, with certain distinctive ones of its own. The species of *Paramœcium* fall into the “*aurelia*” group with more spindle-like bodies and the “*bursaria*” group which are somewhat shorter and broader, with a tendency toward a dorso-ventral flattening.

Now the new species represents the "*aurelia*" type as regards the micronuclei (two in number, and of the endosome type), while in other features it belongs to the "*bursaria*" group. J. A. T.

**Long-continued Pedigree Culture of *Paramœcium aurelia*.—**LORANDE LOSS WOODRUFF (*Proc. Nat. Acad. Sci.*, 1921, 7, 42-4). Reporting on Dec. 30, 1920, Woodruff notes that the culture begun in 1907 has lasted for 13½ years, exhibiting about 8,400 generations. Thus the conclusion is still justified that conjugation is not a necessary phenomenon in the life-history of *Paramœcium aurelia* under favourable environmental conditions. But the internal reorganization process called endomixis occurs regularly. Whether this endomixis is necessary for the continuance of the race is another question. J. A. T.

**Effect of Cutting during Conjugation. —**GARY N. CALKINS (*Journ. Exper. Zool.*, 1921, 34, 449-70, 10 figs.). Pairs of conjugating individuals of *Uroleptus mobilis* were cut across. They unite by their anterior ends and the free bodies extend outwards like the two arms of a V. A successful operation cuts the V at the apex, giving two pieces if the cut is in the long axis, or three pieces if it is transverse. One of the arms (and the apical piece if the cut is transverse) is immediately fixed and stained. The other arm, representing the second individual of the pair, is placed in fresh culture medium in the same manner as a normal ex-conjugant. As the processes of nuclear change are synchronous in the two individuals, the permanent preparation furnishes a picture of the nuclear apparatus with which the experimental animal starts. The striking general result is that although the union of nuclei in the two conjugating individuals is prevented, the changes go on as if the conjugation had continued to the end. Cutting the cell and severing protoplasmic connexions with the second individual in conjugation does not stop the succession of cellular processes after they have been once started. The entire series of maturation and reorganization processes appears to be set in motion by the first contact of the conjugants. The experiments indicate that metamorphosis of the nuclei and cell is an "all or none" phenomenon, which once started goes through to the end of reorganization whether the companion cell is associated with it or not, and with this process of reorganization is associated the renewal of vitality of the protoplasm and a new life-cycle. J. A. T.

**Consequences of Conjugation in *Paramœcium*.—**JULJUSZ ZWEIBAUM (*Archiv. Protistenkunde*, 1921, 44, 99-114, 2 figs.). Experiments with *Paramœcium caudatum* show that there is a marked increase in the oxydation-activity after conjugation, and that this continues for four to five months. There is an increase in surface after conjugation (23 p.c.), but the oxygen-absorption increases much more (147.5 p.c.). The re-organization of the macronucleus probably means a re-activation of the oxydation-ferments of the macronucleus. J. A. T.

**Production of Reserve Material after Conjugation. —**JULJUSZ ZWEIBAUM (*Archiv. Protistenkunde*, 1922, 44, 375-96, 2 pls.). A study of *Paramœcium caudatum* leads to the conclusion that at the time of

conjugation the amount of glycogen in the cell is reduced to a minimum. After the reconstruction of the macronucleus and the re-establishment of the oxydation-function, there is a marked increase in the amount of reserve-material, and the amount reached lasts for five to six months after conjugation. It appears that the individuals that conjugate differ markedly in their glycogen-content. After conjugation the fat is mainly represented by neutral fats. There is little in the way of cholesterin esters. Before conjugation the large drops of neutral fat disappear; numerous fat droplets of another kind appear, and among these small, but increased, amounts of cholesterin esters and large quantities of what are probably fatty acids. After conjugation the neutral fats are restored. Continued metabolism paralyses the macronucleus; conjugation frees the macronucleus from toxic inhabitants.

J. A. T.

**Function of Contractile Vacuole.**—ADOLF HERFS (*Archiv. f. Protistenkunde*, 1922, 44, 227-60). An interesting series of observations on *Paramecium*, *Gaestryla*, and *Nyctotherus*, which go to show that a function or the chief function of the contractile vacuole is to pump out water from the cell and thus protect the cytoplasm from dilution.

J. A. T.

**Study of Opalina.**—STEFAN KONSULOFF (*Archiv. f. Protistenkunde*, 1922, 44, 286-345, 2 pls., 6 figs.). The pellicle in *Opalina* is provided with myonemes which bend the margin in the flat species and produce longitudinal ridges in the cylindrical forms. The bendings and ridgings help in steering. There is an internal framework of supporting fibrils in a network, strained by the functioning of the myonemes. The body-form tends to downward movement (geotaxis). The ectoplasm may pass from a homogeneous to a vacuolated state. What have been called "disc-like corpuscles" are true macronuclei which divide amitotically. They disappear in the reproductive phase. What have been called "nuclei" are the micronuclei. The chromidia which pass out from the nuclei disintegrate. In *Opalina ranarum* there are excretory vacuoles (non-contractile) and a network of canals. Waste-bodies, often minute crystals, are common in the endoplasm. Cysts may be formed when the conditions are unpropitious or in some other cases. There are macro- and micro-gametes in *O. ranarum* and anisogamous conjugation, resulting in cystozygotes. There is nutritive osmosis and some evidence of extra-cellular digestion of adjacent particles. The genus should be placed in the Ciliata near *Anoplophrya*, *Hoplitophrya*, *Discophrya*, and *Opalinopsis*.

J. A. T.

**Structure and Habits of Spathidium spatula.**—LORANDE LOSS WOODRUFF and HOPE SPENCER (*Journ. Exper. Zool.*, 1922, 35, 189-202, 1 pl., 8 figs.). This ciliated Infusorian does not possess trichocysts, and consequently cannot paralyse its prey by this method. It has trichites in the oral region, like a supporting paling, but there is no conclusive evidence that they are the locus of the poison. There are clearly defined micronuclei. The food is limited to small ciliates, but not to members of the genus Colpidium. It seems to come in contact

with its prey solely by chance. Prey which has been paralysed, and has become removed from the oral region of the *Spathidium*, is recovered in the majority of instances by a complex series of successively modified reactions, indicating "sensing at a distance." The factor involved in "sensing at a distance" is apparently a substance secreted by the *Spathidium* when the prey is paralysed.

J. A. T.

**New or Rare Flagellates.**—A. PASCHER (*Archiv. Protistenkunde*, 1921, **44**, 119–42, 10 figs.; 1922, **44**, 397–407, 13 figs.). Descriptions of numerous forms, e.g. species of *Mallomonas*, *Platymonas*, *Reckertia*, *Thaurilens*, *Solenicola*, *Chrysococcus*, *Uroglenopsis*, *Dinobryon*, *Dicerias*, *Styloceras*, *Pseudomallomonas* and *Bernardinella*. Over sixty different forms are dealt with which are new or little known.

J. A. T.

**Australian Fresh-water Flagellates.**—G. I. PLAYFAIR (*Proc. Linn. Soc.*, 1921, **46**, 99–146, 9 pls., 3 figs.). A description of a multitude of forms, which should perhaps be referred to Algæ. The list includes 172 forms in 39 genera, 105 species, 62 varieties, and 5 "forms." Of these there are 43 species, 48 varieties, and 5 "forms" which may be called new. There is a very rare type requiring a new genus, *Scintilla*.

J. A. T.

**Folliculina boltoni.**—RICARDO THOMSEN (*Archiv. Protistenkunde*, 1921, **44**, 83–98, 17 figs.). Corroboration of the report of Kent and Penard that there is a fresh-water species of *Folliculina* (*F. boltoni*), and that it occurs in localities so widely apart as Europe and Uruguay. There is a membrane covering the large "wings," the only case in Stentoridae. But what Möbius described and drew as a membrane consists of membranellæ, which hold the food-particles in the gullet and drive them further in.

J. A. T.

**Trichomonas of Guinea-pig.**—E. C. FAUST (*Archiv. Protistenkunde*, 1921, **44**, 114–8, 1 pl., 1 fig.). A description of *Trichomonas flagelliphora* sp. n., found in the intestine of the guinea-pig, but different from *T. caviæ* in having a smaller body, a longer axostyle, longer undulating membrane and flagellar filament. The long anterior flagella and the presence of chromatic granules along the axostyle are likewise specific.

J. A. T.

**Studies on Chrysomonads.**—F. DOFLEIN (*Archiv. Protistenkunde*, 1922, **44**, 149–213, 5 pls., 3 figs.). A detailed study of *Ochromonas granularis* Dofl., dealing with its nutrition, behaviour in different cultures, division, basal corpuscles, nucleus, and cysts. Special attention is devoted to the nucleus, its two chromosomes, the karyosome, the formation of the spindle, and the basal granules from which the flagella grow out. The second part of the paper deals with *Chrysamöba radians* Klebs, with its flagellate, amœboid, and encysted phases.

J. A. T.

## BOTANY.

(Under the direction of A. B. RENDLE, M.A., D.Sc., F.R.S., F.L.S.)

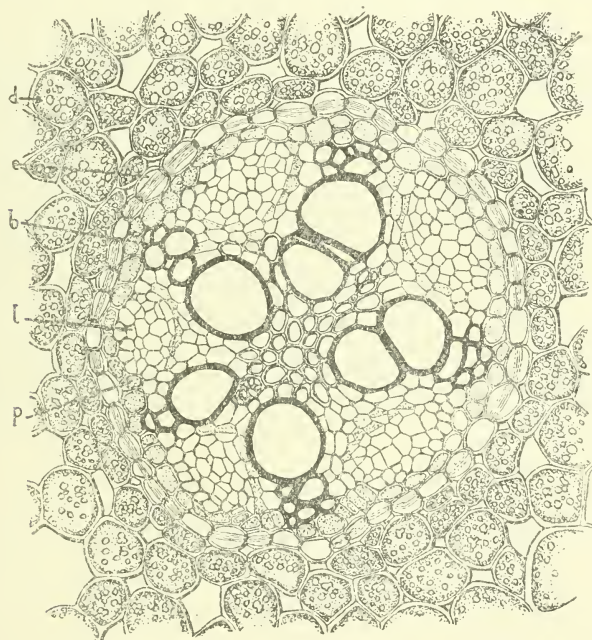
## GENERAL,

Including the Anatomy and Physiology of Seed Plants.

## Structure and Development.

## Vegetative.

Cambium in Root of *Acorus Calamus*.—A. MAILLEFER (*Bull. Soc. Vaud. Sc. Natur.*, 1920, 53, 77-9, 1 fig.). A short study of the anatomy of the root of *Acorus Calamus*, with special reference to the

Central part of a transverse section of the root of *Acorus Calamus*.

e, endodermis; b, vascular bundle; l, phloem bordered towards the interior by a layer of cambium; p, pericycle.

significance of a layer of active cambium between the xylem and phloem. This layer plays an insignificant part in secondary increase of thickness, since it only gives rise to a few cells of phloem-parenchyma, and never

forms any xylem elements. Attempts to induce further growth by the removal of some of the roots from the rhizome resulted in the formation of new roots, but had no effect upon the activity of the cambium. Owing to the presence of this cambial layer and to the small number of vascular bundles, the root resembles that of a typical dicotyledon, but is like a monocotyledon in having one or two large vessels on the inner side of each bundle. The author believes that this root may be of special interest in connexion with the phylogeny of the angiosperms.

S. G.

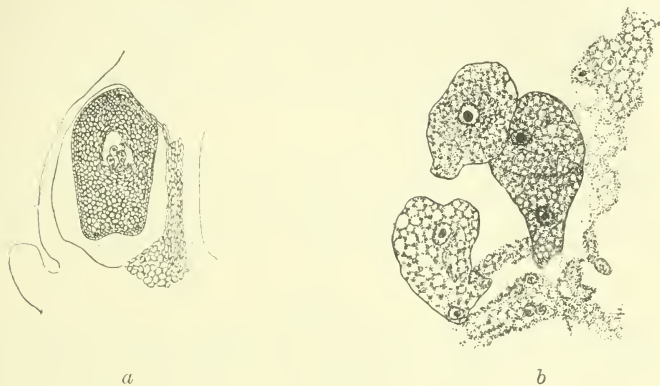
**Experimental Investigations on Birch and Oak.**—EDITH S. WHITAKER (*Bot. Gaz.*, 1921, **71**, 220–34, 4 pls., 4 figs.). An account of an experimental investigation of the effects of wounding upon the ray-structure of *Betula* and *Quercus*. Angiospermous trees have three types of rays—namely, aggregate, compound, and diffuse; the first of these appears to be the most primitive, and by different processes of evolution this type has given rise to the compound and diffuse rays. All wound-reactions occurring in woody tissues must be considered in relation to conservative regions, to seedling structure, and to fossil record, because only in this way is it possible to estimate whether the results of wounding are true reversionisms or not. It is found that all reactions are not true reversionisms, and extreme hypertrophy is unfavourable to reversion. In *Betula* the wound-cap is large and hypertrophy is very marked, so that reversionary features are not found in this region, but in the cylinder opposite the wound. It is interesting to compare this result with that induced in *Abies* under similar conditions. In this case marginal ray-tracheids appear as in *Betula* in the region remote from the wound. In *Quercus* the wound-cap is small and there is no marked hypertrophy, and consequently reversionary features appear in the wound-cap itself. This result resembles the formation of traumatic resin-canals in the immediate neighbourhood of the wound-cap in *Abies*. The author points out that experimental investigations of this character are of interest not only from a biologic and pathologic standpoint, but also because they may show the possibility of producing new types of ornamental wood.

S. G.

#### Reproductive.

**Comparison of Development in *Cuscuta* and *Convolvulus*.**—GERTRUDE E. MACPHERSON (*Bot. Gaz.*, 1921, **71**, 392–8, 3 pls.). A comparison of the development of the embryo of *Cuscuta Gronovii* Willd. and *Convolvulus sepium* L. The youngest embryo observed in *Cuscuta* consisted of a large basal cell surmounted by a smaller apical cell; at a later stage the usual form is of an elongated and swollen base, having either no suspensor or a unicellular one. Later on both spherical and elongated forms are found, but there is no indication of plerome or periblem, nor of any differentiation into dermatogen. In the latest stages the embryo is large and well developed, coiled into spirals which lie in the scanty endosperm of the mature seed. The mature embryo bears two small scales, but except for some enlarged masses of undifferentiated tissue on the sides of the embryos, there are no traces of

cotyledonary growth. During the early stages the development of the embryo in *Convolvulus* is the same as that in *Cuscuta*, but a larger vacuolate suspensor is typical of the older embryos of the former. Poly-



*a*  
Embryo-sac of *Convolvulus*  
*sepium*, showing poly-  
embryonic condition.

*b*  
One- and two-celled embryos  
more highly magnified.

embryony is the rule in *Convolvulus*, but no case was observed in *Cuscuta*; the synergidal cells give rise to the numerous embryos in *Convolvulus*. In both species the endosperm is the result of free nuclear division. S. G.

## CRYPTOGAMS.

### Pteridophyta.

Development of Prothallia and Antheridia from the Sex-organs of *Polypodium irioides*.—W. N. STEIL (*Bull. Torrey Bot. Club*, 1921, 48, 271-7, pl. and figs.). In an old culture of prothallia of *Polypodium irioides*, the sterile cells of a large number of antheridia and archegonia became vegetative like ordinary prothallial cells. The lid and the ring cells of the antheridia produced prothallial filaments and secondary antheridia. The archegonia produced similarly from the neck and the venter cells filaments and antheridia, but in no case secondary archegonia. At some time during their course of development, antheridia were transformed into prothallia. No such transformations were observed to occur among the archegonia. The prothallia produced from the sex-organs resembled those formed from the germination of a spore. Secondary antheridia arising from antheridia and archegonia developed actively motile antherozoids. Unusual cultural conditions probably diverted the sex-organs of *Polypodium irioides* from their normal course of development. No similar case of regeneration has been previously reported in a Pteridophyte. A. GEPP.

Synopsis Hymenophyllacearum.—R. B. VAN DEN BOSCH and W. A. GODDIJN (*Mededeelingen Rijks Herbarium Leiden*, 1913, No. 17, 36,

23 figs.). A revised edition of the classification of the difficult group of the Hymenophyllaceæ, published by the late R. B. van den Bosch, enriched with numerous notes and drawings left by that expert at his death in 1862. Descriptions are given of genera and sub-genera, and where necessary of species, with synonymy and references to literature, also distribution and collectors' names and exsiccatae-numbers. The present instalment treats of the following genera of Trichomanoideæ:—*Cardiomanes*, *Fleæ*, *Neuromanès*, *Cephalomanès*, *Trichomanès* (sub-genera: *Gonocormus* and *Microgonium*). A. G.

**Synopsis Hymenophyllacearum.**—R. B. VAN DEN BOSCH and W. A. GODDIJN (*Mededeelingen Rijks Herbarium Leiden*, 1919, No. 38, 41, 22 figs.). This instalment, the second, treats of the genus *Trichomanès* (sub-genera: *Ptilophyllum*, *Craspedoneuron*, *Crepidomanès*). A. G.

### Bryophyta.

**Illustrations of Six Species of Riccia, with the Original Descriptions.**—CAROLINE C. HAYNES (*Bull. Torrey Bot. Club*, 1920, 47, 279–87, 6 pls.). Good drawings of the following North American species of *Riccia*, which have never previously been adequately figured:—*R. Donnellii*, *R. dictyospora*, *R. Beyrichiana*, *R. arvensis*, *R. hirta*, *R. Curtisii*. With them are published in full the original descriptions, some of which are difficult of access, also data as to distribution and synonymy. *R. Beyrichiana* Hampe (1838) has for synonym *R. Lescuriana* Austin (1863). *R. Curtisii* James (1869) was originally described as the type of a new genus, *Cryptocarpus* Austin (1864), afterwards changed by Lindberg to *Thallocarpus*. A. GEPP.

**Researches on the Marchantieæ.**—ROBERT DOUIN (*Revue Gén. de Botanique*, 1921, 33, 34–62, 99–145, 190–213, 16 pls. 45 figs.). A fresh study of the morphology of the Marchantieæ, treating of the growing point, the ramification, the development of the reproductive apparatus, and proposing a new classification founded on constant characters. The author shows that the growing point is a single cell, and not a group of cells. He explains the ramification of the thallus, and shows that the types of ramification are very varied, some of them having escaped the observation of students: for example, that of “bifurcation contrariée,” as in *Peltolepis*, *Sauteria* and *Exormotheca*. Incidentally he has detected the true origin of the male and female apparatus, and shows that the female apparatus, as well as the peduncled male apparatus, is not a mere prolongation of the thallus, but always springs from a special vegetative point arising above or below the growing point of the thallus. He finds that the archegonia are terminal only in the involucrate Marchantieæ, which are thus the only acrogenous forms. Also the pedunculate apparatus, both male and female, is more complicated than had been generally supposed, owing to the presence of a small basilar thallus which has hitherto escaped notice. Further, the so-called involucre which protect the sporogonia have very different morphological origins. In the Marchantieæ inferiores they have a thalline structure, but not so in the Marchantieæ

involutratæ, and in the Marchantiæ lobatæ and radiatæ they show but a partially thalline structure. It is also necessary to recognize that there are profound differences, both morphologic and physiologic, between the *lobes* and the *rays* of the capitulum; these terms were applied by Nees ab Esenbeck to *Marchantia polymorpha*, and have been employed by subsequent authors in a contradictory manner. In the female capitula and male discs with channelled peduncles there is an arrangement for water-absorption which has never been investigated from the point of view of direct or indirect alimentation; and from studying it the author has found proof that (contrary to current ideas) all fruit-bearing apparatus and all pedunculate male apparatus is effectively constituted of an agglomeration of thalli which proceed from diverse ramifications of the same initial thallus. On the strength of all these facts, and in the light of other critical observations, the author shows that the existing classification of Marchantiæ cannot be maintained, relying as it does partly on inexact facts and partly on inconstant characters. He therefore proposes a new classification founded on other characters more important and less ambiguous—characters which by their constancy and simplicity permit almost always the determination of groups and genera with the help of a simple lens, if not by the unaided eye. The group divisions are as follows:—(I.) Marchantioideæ non sulcatæ include (1) Involucratæ nec sulcatæ (*Clevea*, *Lunularia*); (2) Subinvolucratæ (*Plagiochasma*). (II.) Marchantioideæ sulcatæ include (3) Inferiores (*Corbierella*, *Exormotheca*, *Fegatella*); (4) Involucratæ sulcatæ (*Sauteria*, *Peltolepis*); (5) Lobatæ (*Reboulia*, *Neesiella*, *Grimaldia*, *Fimbriaria*, *Dumortiera*, *Bucegia*); (6) Radiatæ (*Preissia*, *Marchantia*).

A. G.

#### Embryogeny and Sporogenesis in *Reboulia hemisphærica*.—

ARTHUR W. HAUPT (*Bot. Gaz.*, **71**, 1921, 446–53, pl. and figs.). A continuation of a previous paper (*tom. cit.*, 61). (1) The embryo of *Reboulia* develops without formation of an octant stage characteristic of some other Marchantiaceæ. (2) The first transverse wall in the fertilized egg separates off the foot-forming cell from that which is to form the seta and capsule. Four horizontally super-imposed cells usually occur, each new one being cut off from the outermost segment. From the lowest of the four arises the foot, from the next the seta, from the upper two the capsule. (3) The sporogenous tissue is formed relatively early. (4) In the development of spore mother-cells and elaters the walls around the sporogenous cells become mucilaginous, the protoplasts of the former assume an amœboid form, and finally become large and spherical, while those of the latter are slender and elongated. A new cell wall is laid down around both spore mother-cells and elaters. The assumption of an amœboid form by the young mother-cells is a feature related to their nutrition. (5) An elater in *Reboulia* is homologous with a single-spore mother-cell, and not with a row of them. (6) The exine and intine are differentiated in the tetrad stage, and the epispore has begun to develop. The formation of a double spiral band on the elaters is accompanied by a condensation and ultimate disappearance of the protoplasm. (7) The short seta and bulbous foot are primitive features of the genus.

A. G.

**The Genus *Riccardia* in Chile.**—ALEXANDER W. EVANS (*Trans. Connecticut Acad. Arts and Sci.*, 1921, 25, 93-209, 13 figs.). A systematic account with detailed descriptions of the 25 species of the hepatic genus *Riccardia* (often known as *Aneura*) which have been recorded for Chile. A further 8 species, about which there is more or less uncertainty, are excluded from the list. The plants described as new to science are 3 in number—*R. Thaxteri*, *R. diversiflora*, *R. mycophora*. Synonymy, distribution, and critical notes are given; a key is provided, and 22 of the species are illustrated. The generic characters of *Riccardia* are discussed, as also are its affinities and phylogeny.

A. G.

***Jungermannia stygia* Hook. f. & Tayl.**—W. H. PEARSON (*Proc. Roy. Soc. Tasmania*, 1921, 166-7, 1 pl.). This hepatic from Campbell's Island is shown to have been described from a mixture of two quite different plants; one (figured by Hooker in his *Flora Antarctica*) with rotundate leaves is probably a *Jamesoniella*; the other with widely emarginate leaves is a *Gymnomitrium*, not distinguishable from *G. concinnatum*, and is clearly the type intended by Hooker and Taylor. Further, Rodway, in his List of Tasmanian Hepatics, is in error in citing *Cesia erosa* Carr. & Pears. as a synonym of *G. concinnatum*. *C. erosa* is a good species; it is monœcious and has its leaves margined with a row of acute elongated cells. Stephani, in his *Species Hepaticarum*, erred in regarding *C. erosa* as a synonym of his *Acolea stygia*.

A. G.

***Rhacopilopsis trinitensis* E. G. Britt. & Dixon.**—H. N. DIXON (*Journ. of Bot.*, 1922, 60, 86-8). An account of a moss which has been described under four different specific names, and been placed in seven genera. It occurs on both sides of the Atlantic, in Trinidad and Cayenne on the one hand, and in Angola, Congo and Nigeria on the other, and is characterized by its dimorphic leaves, the lower row of which are but half the width of the others.

A. G.

**Muscineæ of the Wirral.**—W. A. LEE and W. G. TRAVIS (*Lancashire and Cheshire Naturalist*, 1921, 14, 35-48, 75-91, 130-42). An account of the local Bryophyte flora. The Wirral occupies a peninsula between the estuaries of the Mersey and the Dee. The physical geography of the area is discussed, and lists are given of the species found on peaty heaths, shore clay banks, and dune tracts. Important changes have occurred since F. P. Marrat's records were made seventy years ago. The dune slacks have dried up, and the aquatic species characteristic of them have disappeared; the resident population has vastly increased, from the overflow of Liverpool; and many species, especially corticolous, have been exterminated by the smoke-polluted atmosphere. The list contains 183 mosses, 57 hepatics, and numerous varieties; but many of these (45 mosses and 9 hepatics) are already extinct.

A. G.

**Mosses of the Bureau of Soils Kelp Expedition to Alaska.**—J. M. HOLZINGER and T. C. FRYE (*Publ. Puget Sound Biol. Sta.*, 1921, 3, 23-64, figs.). An enumeration of the mosses collected in

1913 by the two parties of the Kelp survey, mostly in situations near the seashore. The list includes 198 species and 25 varieties, 2 species and 1 variety being new to science; 2 species are new to North America, and 44 were previously unrecorded for Alaska. Detailed figures are given of *Dicranella squarrosa*, *Bryobrittonia pellucida*, and *Trachycystis flagellaris*. A reasoned appeal is made for the re-establishment of the genera *Trachycystis* and *Geheebia*. The distinguishing characters of *Zygodon Reinwardti* and *Z. gracilis* are displayed in parallel columns.

A. G.

### Thallophyta.

#### Algæ.

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#### MRS. E. S. GEPP.

IT is with much regret that we have to record the death on April 6 of Mrs. Gepp, who for many years has supplied the abstracts dealing with Algæ. By her careful work on the morphology and taxonomy of sea-weeds, some of which was published under her maiden name—Ethel Sarel Barton—Mrs. Gepp had gained a prominent position among algologists, when in 1911 a complete breakdown in health necessitated a removal to Torquay and a cessation of active work. By extreme care and devotion her life was prolonged; and though cut off from active participation in scientific work she was able to continue the abstracting for the Society's Journal. Her help in matters relating to the study of sea-weeds was also from time to time available through the medium of her husband and co-worker. A joint paper by Mr. and Mrs. Gepp on the Marine Algæ of the British Antarctic ("Terra Nova") Expedition was published in 1917. A full account of Mrs. Gepp's work will appear in the "Journal of Botany."

A. B. R.

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Plankton and other Biological Investigations in the Sea around the Faeroes in 1913.—O. PAULSEN (*Medd. f. Kommiss. f. Havundersøgelser. Ser. Plankton*, I., No. 13, 1918, 1-27; see also *Bot. Centralbl.*, 1919, 141, 278). Part I. contains a description of the *Laminaria* forests in Frangisvaag fjord in the Faeroes. These forests play an important economic rôle in the production of organic matter, and in forming shelter for fish and other animals. They occur everywhere within the 20 m. line, but as a rule not outside it. A list of benthic diatoms is given, determined by Destrup. Part II. gives a detailed investigation of the plankton of the same fjord. From May 28 to June 16 a sample was taken every day, treated centrifugally and counted.

Only slight variation in the composition of the neritic plankton was found, while the quantity varied greatly. Comparison is made with another series of samples taken on different days with plankton nets from the innermost part of the fjord to the water outside it. The outer fjord yielded a flora differing from the inner both in quantity and quality, explicable on the assumption of an inflowing and an outflowing current. Part III. treats of the species in the stomachs of fishes. Part IV. deals with the plankton of the Faeroe Bank, 50 miles to the south-west, rising from deep-water. The plankton above the Bank is partly neritic, and in quantity exceeds that in the deep-water around. And the greater coldness and freshness of the water above the Bank suggest that it has been brought up to the surface by vertical currents. On the coasts of the Faeroes, too, there are similar vertical currents; hence the resemblance between the neritic plankton and the Bank plankton.

E. S. GEPP.

Phosphorescent Water and its Protection in Japan.—M. MIYOSHI (*Bot. Mag. Tokyo*, 1915, 29, 51–3, 1 pl.). An account of some examples of phosphorescence in fresh-water in Japan. The effect is due to the presence of *Chromulina Rosanoffii*, one of the Chrysomonadinae, long known in Europe. It imparts a golden gleam to the surface of the water, a phenomenon comparable with that afforded by the luminous moss, *Schistostega osmundacea*.

A. GEPP.

*Coelastrum proboscideum* Bohl.: A Study of Experimental Planktology, followed by a Revision of the Swiss Species of *Coelastrum*.—T. RAYSS (*Matériaux pour la flore cryptog. suisse*, 1915, 5, 2, 66, 20 pls., 2 figs.; see also *Bot. Centralbl.*, 1918, 137, 265). The species in question was cultivated at Geneva. Its polymorphism is remarkable: coenobia, forms resembling *C. sphaericum*, botryoid compact forms with roundish or lobed cells, and isolated cells resembling *Chlorella* or *Polyedrium*. These variations must be regarded as reactions to different media. *Coelastrum* occurs generally as a coenobium, which may, however, fall apart into separate rounded or polyhedral cells. This is often seen in media of increasing concentration, and apart from mechanical external influences. Coenobia occur principally in media of weak concentration, or in higher temperatures. Both these factors diminish the viscosity of the medium. This confirms experimentally the theories of Ostwaldt. Nutrition has the effect of enlarging isolated cells and bringing about an increase in the number of individuals. Respiration is another influential factor. In more or less completed anaerobiosis, isolated cells are mostly produced; the presence of oxygen produces coenobia. The dismemberment of coenobia appears to provide a larger surface for respiration. Peptone works harmfully, in so far as it leads to a separation of oil and the dismemberment of the coenobia; but also usefully, in so far as the alga itself in the presence of sugar retains for a long time its chlorophyll. Calcium salts (a proportion of 0.25 to 1.75 p.c.) hasten the development of *Coelastrum*, and increase the dimensions of the isolated cells and of the coenobia. Potassium salts (0.5 to 1.75 p.c.) hinder the formation of coenobia. KCl alters the cell-contents more or less. Free acids are favourable: the coenobia, and the cells which form

them, become smaller. Alkalies in a proportion of 0.1 to 0.5 p.c. of NaOH after neutralization of the medium are favourable, and become in time partially neutralized. The systematic revision of the genus records six species of the section *Eucoelastrum* Wille, one being new. The author makes a new section, *Clathrestum*, in which hyaline cylindrical lateral prolongations occur binding the cells together, and this includes *Eucoelastrum*, together with *C. Chodatii* Duc. and *C. reticulatum* Lemm. Synonymy and distribution are given. The polymorphism of *C. proboscideum* is figured.

E. S. G.

**A New Species of Coelastrum.**—F. RICH (*New Phytologist*, 1921, 20, 234–8, figs. in text). The species here described, *C. schizodermaticum*, was collected in a ditch on the Groby Road, near Leicester. The coenobium consists of two, four, eight or more, rounded cells, eight being the commonest number. The peculiarity of this organism is the splitting off of little cap-like structures from the free surfaces of the cells. Minute pads appear at first, about  $\frac{1}{3}$ th or  $\frac{1}{4}$ th of the circumference apart; then fission of the outer layer of the cell-wall seems to occur along a line connecting at least two of these pads, and a little circular or four-cornered cap is detached. An eight-celled colony with the little caps well defined presents a very characteristic appearance. The small pads may correspond to the special short truncate processes or warts that unite the cells in *C. Morus*, *C. scabrum*, *C. cambricum* and *C. reticulatum*. The formation of auto-colonies by the cells of an entire colony has not been observed. Indications point, however, to a possible formation of daughter colonies by single cells, produced by disintegration of adult coenobia the daughter colony being at first enclosed within the mucilaginous wall of the parent cell. Fifteen different stages of the organism are figured.

E. S. G.

**Hormiscia tetraciliata.**—T. C. FRYE and S. M. ZELLER (*Puget Sound Marine Station Publications*, 1915, 1, 9–13, 1 pl). An account of a new marine species of *Hormiscia* which is remarkable as having gametes provided with four cilia instead of the normal two. A full description and figures of the plant are given. It is recorded from six stations in Puget Sound on the West Coast of America.

A. G.

**Notes on the Zygnemales.**—E. N. TRANSEAU (*Ohio Journ. Sci.*, 1915, 16, 17–31; see also *Bot. Centralbl.*, 1919, 141, 279). New species are described of *Debarya*, *Zygnema*, and *Spirogyra*.

E. S. G.

**New Oedogoniaceæ.**—E. N. TRANSEAU and H. TIFFANY (*Ohio Journ. Sci.*, 1919, 19, 240–2; see also *Bot. Centralbl.*, 1919, 141, 279). Descriptions of *Oedogonium hystricinum*, *O. pisanum* var. *gracilis*, and *Bulbochaete Bullardi* as novelties.

E. S. G.

**Two New Schizophyceæ Symbioses.**—V. BREHM (*Naturwiss. Wochenschrift*, 1917, 12, 287–8; see also *Bot. Centralbl.*, 1919, 140, 264). As regards the much-discussed *Geosiphon* Wettst., and the shell-enclosed rhizopod *Paulinella chromatophora* Lauterb., it is a case according to the author of secondary chlorophyll-free existence, which compensates for the loss of its original assimilatory contents by

symbiosis with Schizophyceæ. A discussion follows on the possible application of Dollo's law to physiological phenomena. Both the alga *Geosiphon* and the rhizopod *Paulinella* represent a new type of symbiosis, and support the views of Schimper, Mereschowsky and Lauterborn on chromatophore symbiosis. E. S. G.

Formation-biology of the Algæ of the Zehlan Fen in East Prussia.—F. STEINECKE (*Arch. Hydrobiol. Planktonk.*, 1916, **11**, 458–77, 10 figs.; see also *Bot. Centralbl.*, 1919, **140**, 264). A repetition of a former account of this somewhat inaccessible region, published by the same author in 1915, and abstracted in this Journal. E. S. G.

Fresh-water Algæ from Juan Fernandez and Easter Island.—K. M. STRÖM (*Nat. History of Juan Fernandez and Easter Island*, ed. by C. Skottsberg, II., *Upsala*, 1921, 85–93). A record of twenty-five species, including two Desmids. Very few came from Easter Island. The material was collected by Dr. Skottsberg in 1916–17 during the Swedish Expedition to the Pacific. The majority of the algæ are ubiquitous species. The Myxophyceæ are represented by thirteen species. One of these, recorded as "*Oscillatoria* sp.," bears a striking similarity to *O. terebriformis* f. *tenuis* (W. & G. S. West), hitherto only known from Cape Royds, Victoria Land. The filaments were very little if at all terebriform, but this character was also not very striking in the Antarctic specimens. E. S. G.

Catalogue of Fresh-water Algæ Collected in the Caucasus: A. A. Elenkin and V. P. Savicz in the Czernomorsk Region during the Summer of 1912.—A. I. LOBIT (*Bull. Jard. imp. bot. Pierre le Grand*, 1915, **15**, 23–47, 6 figs.; see also *Bot. Centralbl.*, 1918, **137**, 235). A record of sixty-five species, with notes. Two new forms are described in Russian: *Spirogyra ternata* Rip. f. *gagrensis*, and *Cosmorium holmiense* Lund f. *caucasicum*. *Scytonema tolypotrichoides* Kütz. is regarded as a variety of *S. mirabile* Bornet. Figures are given. E. S. G.

The Germination and Development of some Marine Algæ. I. Porphyra.—K. YENDO (*Bot. Mag. Tokyo*, 1919, **33**, 73–93, 1 pl.). The first of two important reports published before the death of the distinguished author. His problem was to determine, if possible, what happens to "annual marine algæ" during their resting period, when they are not in evidence; and a further mystery is what at such a time becomes of the epiphytic and endophytic species proper to "annual algæ." The subject of this paper is *Porphyra*, as represented by two littoral species, *P. leucosticta* var. *suborbiculata* (Kjellm.) and *P. linearis* Grev., which grow richly from December to May near Oshoro Cove, where the Marine Laboratory of Hokkaido Imperial University is situated. A suitable block of concrete was erected, conforming in all necessary details to natural reefs, and bearing on the surface a number of knobs which could be detached for examination at stated intervals. Sporelings of *Porphyra* were found on Oct. 27, the youngest being single cells, roundish elliptical. These sporelings increase in length and divide, developing into the young plants already described by

former authors. Okamura and the present author both supposed that these plantlets were the product of germinating carpospores, but further observation disproved this. In February and March *P. leucosticta* was found growing richly on the concrete block, and early in April fronds bearing mature carpospores were placed under observation. The liberated carpospores sank to the bottom of the glass vessel and began to germinate at the beginning of the second week after the liberation. A protonema-like growth was developed which became elongated, and branched sporangia were formed by the transformation of the terminal cell of a branch, or of an intermediate cell of the principal filament; the gametes were of two kinds, large and small. Both moved actively in water, but flagella were actually observed in the macrogametes only. The whole process took about five weeks. The discovery of heterogametes in *Porphyra* gives rise to further problems as to the position of Bangiaceæ, and to the need of following the germination of carpospores in Euflorideæ. Certain points of difference were apparent between the single-celled sporelings of autumn and the rounded carpospores liberated from mature fronds in spring, which may possibly be evidences of their different origins. The various stages of development described are well figured.

E. S. G.

**Cytological Studies on *Porphyra tenera* Kjellm. I.—M. ISHIKAWA** (*Bot. Mag. Tokyo*, 1921, 35, 206-18, 1 pl., figs. in text). This alga, the "asakusanori" of commerce, is much cultivated for food purposes in Japan. Material was collected in Tokyo Bay, November to March, 1920 and 1921, and treated according to methods described. An account is given of the vegetative cell and its division, the spermatium, carpogonium and carpospore: and stages of division of zygote and antheridium are figured. Under phylogenetic observation it is pointed out that the nucleus of *Porphyra* may be regarded as a kind of incipient nucleus, though it differs in some respects from the highly organized type in the nucleus of Cyanophyceæ. The method of nuclear division has a close resemblance to that of *Synechocystis aquatilis*, in having three chromatic filaments and primitive mitosis; and this affinity with Cyanophyceæ is further increased by the possession of phycocyanin and phycoerythrin which is recorded in certain species of Cyanophyceæ. They differ, however, in the presence of a stellate chromatophore and sexual reproduction in *Porphyra*. A connecting link is found in *Porphyridium cruentum*, which has a stellate chromatophore, but no sexual reproduction. *Porphyra* is also allied to Florideæ by the possession of sexual cells, and of a chromatophore containing phycoerythrin. It shows a close relationship to the lower Nemalionales in the presence of a pyrenoid and in the absence of alternation of generations. But it differs from Florideæ in producing carpospores directly from the carpogonium, in the presence of a kind of incipient nucleus, and in the absence of protoplasmic continuity. A table is given showing the distribution of phycoerythrin and phycocyanin in Cyanophyceæ and Rhodophyceæ. *Ulva* differs from *Porphyra* in having a highly differentiated nucleus, and a chromatophore of a different type from that of Bangiales; also in the reproductive organs. In *Bangia fuscopurpurea*

the nucleus, chromatophore, and pyrenoid are identical with those of *Porphyra*. The author concludes that Bangiales, including *Prasiola*, have descended from species of Cyanophyceæ, and Florideæ from Bangiales. Cyanophyceæ and Florideæ are in short connected by Bangiales, the Protoflorideæ of Börgesen. The prevailing characters in this line are a total absence of the ciliary movement of the cell, and the presence of phycoerythrin, or phycoerythrin, or both. E. S. G.

**Somatic Organization of the Phaeophyceæ.**—A. H. CHURCH (*Oxford University Press, Botanical Memoirs*, No. 10, 1920, 110 pp.). An account of the vegetative structure of the brown seaweeds, divided into thirty chapters under the following headings:—Working hypotheses; Origin from pelagic Phytoplankton; The beginning of the benthic soma; Regression and reproduction; Apical growth and ramification; Mechanical support; Ectocarpoid Benthon; The consolidated filamentous soma or "Cable"-type; The multiseptate "Cable"-type; Corticated types; The parenchymatous type; Improved parenchymatous types; The evolution of growing-points; Evolution of systems of ramification; Symmetry; Evolution of Fibonacci phyllotaxis; Differentiation of Space-form, and the theory of members; Evolution of the leaf-member; The branch as hapteron (Crampons); Pneumatocysts and pneumatophores; The evolution of gametophores (Receptacles); The elaboration of differentiated shoot-systems; Theory of tissue-differentiation; Mechanism of tissue-differentiation; Mucilage-hairs and ducts; The pulvinate thallus; The disc type; The palmelloid type; Epiphytes, parasites, endophytes; Summary and conclusion. The Phaeophyceæ are an ancient group of plants remarkable for the almost complete range of forms from unicellular plankton up to massive growths such as *Macrocystis*. They are of the highest importance as indicating the manifold equipment which must have been acquired by the ancestral Chlorophyceæ, some of which migrated from the ocean and established themselves on the dry land, to become eventually our modern Land Flora. A. G.

**Key to the Phaeophyceæ of Puget Sound.**—WALTER C. MUENSCHER (*Puget Sound Marine Station Publications*, 1916, I., 249-84, 49 figs.). An artificial key to the genera, with keys to species, and short descriptions of the genera and species, also habitat notes, and sketches of many of the plants. The characters used are as far as possible field-characters, thus rendering the keys the more useful to collectors. A. G.

**Some Points in the Structure of *Alaria fistulosa*.**—ALICE L. KIBBE (*Puget Sound Marine Station Publications*, 1915, I., 43-57, 3 pls.). An investigation of the fistulose or chambered midrib of the frond. The chambers develop gradually from rifts in the pith, which originate from combined linear and lateral strain. This strain is produced by continued transverse and radial division of the cortical cells, after the medullary cells have ceased dividing. A continuation of this severe strain breaks down the sieve-tubes. The chains of hyphal cells and sieve-tubes torn in the rift deteriorate into a mucilage. The walls

of the chambers thus formed elongate as cortical growth continues. The septa consist of hyphal chains not broken by the rift. Variation in the length of the chambers is due to the breaking of the sieve-tubes at the regions of greatest strain; these regions would naturally occur at unequal distances apart. Specialized sieve-tube areas are developed at the extremities of the pith area; and they appear to prevent undue elongation and strain from tearing down the midrib; and probably they serve also as conducting vessels in the broken pith. Normally the haptera arise at the edge of the lower portion of the flattish stipes, and those arising from the flattish sides remain small and simple. The sporangia and paraphyses develop as they do in *Nereocystis*. In the formation of sporophylls a ridge is first developed along each sharp edge of the flattened rachis. A portion of medullary tissue passes out into each ridge. Rifts form in the medullary region. The ridge becomes irregularly and more and more deeply lobed, until the leaf-like sporophylls, each enclosing a portion of medulla, are formed. A. G.

**Growth of the Fronds of *Nereocystis Luetkeana*.—ANNIE L. FALLIS** (*Puget Sound Marine Station Publications*, 1915, I., 1-8, fig.). Experiments show that the plant will grow as well when loosened from its foothold on the rocks, unless washed ashore or otherwise unfavourably situated. The holdfast serves only to fix the plant, and neither it nor the stipes nor bulb are necessary for the growth of the fronds. If the fronds be cut into very small pieces, each piece will grow independently. The growing region is not situated at the transition place between lamina and stipes. The basal limit of considerable growth is at the beginning of the flattened expanded part of the frond. The terminal limit of the growing region is difficult to fix. Growth gradually decreases towards the tips of the fronds; relatively little growth occurs beyond 2 ft. from the bulb in an ordinary July plant. A. G.

**Notes on the Growth of the Stipes of *Nereocystis Luetkeana*.—SARAH M. SHELDON** (*Puget Sound Marine Station Publications*, 1915, I., 15-8). The stipes grows about the same when loose as when attached. The greatest growth region of the stipes in fairly mature plants is 2 to 4 ft. below the laminae, the rate decreasing towards the ends. The rate of growth measured in July was about 1 in. per day. A cut stipes usually dies from decomposition, apparently due to the action of organisms at the cut surface or within the hollow. A. G.

**Gas Exchange in the Pneumatocyst of *Nereocystis Luetkeana* (Mertens) P. & R.—SANFORD MYRON ZELLER and ABIGAIL NEIKIRK** (*Puget Sound Marine Station Publications*, 1915, I., 25-30). Collections of the gases in the pneumatocysts were made by means of a special apparatus between 3 and 4 a.m. and 3 and 4 p.m. The average variation of carbonic acid from day to night is 2.21 p.c., and of oxygen is 1.398 p.c. The quantity of these gases differs therefore from day to night. The maximum increase of oxygen takes place, as was to be expected, immediately after the time of maximum photosynthetic activity; while the maximum increase of carbonic acid occurs during the night. The greater range in variation of the carbonic acid may be due to its

greater solubility and of its more rapid osmosis to and from the cysts; or it may be due to such unknown factors as the partial pressure of the gases in the mixture, or the varying pressures to which the plants are subjected with the periodic rise and fall of the tides. The source of variation in quantity of both gases is to be traced to the processes of metabolism in the plants. The pneumatocyst not only raises the plant to the light, but serves also as a reservoir in the gas exchange of the metabolic processes, and this ready supply of essential gases may have a bearing on the enormous annual growth of these plants. E. S. G.

**Gas Pressure in Nereocystis.**—T. C. FRYE (*Puget Sound Marine Station Publications*, 1916, I., 85-8). Among the results obtained by investigation are the following: The gases within the air cavity of the cyst average about 77 mm. of mercury below air pressure. The loss of fronds causes a rise of pressure within the air cavity until it approaches or even exceeds that of the atmosphere. There is also a fall of pressure at night, and a lower pressure in submerged plants. These reductions are probably due to changes in temperature. A. G.

**Seasonal Development of Bladder Kelp.**—GEORGE B. RIGG (*Puget Sound Marine Station Publications*, 1917, I., 309-18). A record of observations made during a number of years. *Nereocystis* is an annual plant. Young plants are found in the spring, fruiting plants in the summer, and drifting old plants in the winter. Some survive till the following year. Mortality is great among the sporelings, through desiccation, excessive light, wave violence. These and other factors are discussed. A. G.

**North Pacific Coast Species of Desmarestia.**—VINNIE A. PEASE (*Puget Sound Marine Station Publications*, 1917, I., 383-94, 2 pls.). A preliminary study of the subject, with a history of the genus. Of the species recorded for the region, *Desmarestia aculeata* is fairly common, *D. media* is considered to deserve specific rank, *D. viridis* probably does not occur there, *D. ligulata* is rare, *D. herbacea* is abundant and deserves specific rank, *D. tabacoides* is a curious undivided species described from Japan by K. Okamura in 1908, and now discovered in Puget Sound by the author. A key and some photographic figures add to the value of the paper. A. G.

**The Germination and Development of some Marine Alga.**  
**II. Phyllitis.**—K. YENDO (*Bot. Mag. Tokyo*, 1919, 33, 171-84, 1 pl.). The alga under consideration in this report is *Phyllitis Fascia*, the young shoots of which begin to appear late in October in the vicinity of Otaru Bay. Spores are discharged from late December to the following April. At the end of June the plants are mostly broken away from their attachment, and in July they are no more to be found. Early in April fronds with mature sori were placed under observation in Sapporo Laboratory, and within twenty-four hours the spores were massed on the side of the glass towards the light, being strongly heliotactic. Two cultures were made, but one only, the more successful, is here described. After losing the flagella, the spores become spherical and sink to the bottom of the glass vessel, to which and to each other they adhere by a

gelatinous substance secreted by themselves. This adhesion may, however, be due to artificial conditions. The spherical spores, which are described in detail, rest unchanged for a week and apparently do not copulate. They then thrust out a process which elongates, and division of nucleus and chromoplast takes place, followed by cell division. Further growth is described, up to a protonema-like filament with the initial cell at one end. The cells of the filament increase in size and in number, and in the third week a hyaline hair arises from the initial cell. In the fourth week the filament consists generally of ten to twelve cells, one of which (sometimes more) increases enormously in size, the chromoplast gradually decomposes and the cell is filled with minute hyaline granules lying in mucilage. These develop into spermatozoids, the formation and discharge of which are described. The cells which produce oogonia may be recognized by the unusually intense colour of the chromoplasts, which contain a rich granular substance. The periclinal surface bulges out towards one side, becomes septated at the base, rounds itself off, and becomes detached as a free oospore, about  $10\mu$  in diameter. The process of fertilization was not observed. The oospores rest for a very short period, germinating within a few days of detachment from the mother-cells. Their development was only followed till they formed three-celled filaments, which took place at the end of the fifth week. The author suggests that the caespitose habit of *P. Fascia* may be due to the aggregations of the oospores and not of the zoospores. He regards the swarmspores as asexual, and therefore, in the life-history of *Phyllitis*, a gametophyte generation follows the sporophyte. What becomes of the sporeling germinated from the oogonium, during the half-year until the appearance of the well-known form of *P. Fascia* in late autumn, is not known.

E. S. G.

**Researches on the Variation of Iodine in the Principal Laminarias of the Breton Coast.**—P. FREUNDLER and Y. MENAGER (*Office Sci. et Techn. Pêches Maritimes, Paris: Notes et Mémoires, No. 13, 1922, 24 pp.*). A continuation of the report on the economic use of *Laminaria*, published as No. 5 of these memoirs. The following results have been obtained. No *Laminaria* survives beyond the winter if the frond has been injured; consequently, collection of material by cutting was discontinued during last year. The tearing off of plants in collecting prevents or hinders the attachment and development of young plants. Intensive exploitation by boats causes a diminution in the size and number of the algæ, although it does not cause all the serious damage imputed to it. The mode of collecting should be methodical and discontinuous. The method of determining the quantity of iodine has been improved, and can be accurately stated within an error of 2 p.c. The results obtained are:—1. A general diminution of the amount of iodine during desiccation. 2. The variation of this amount under the influence of season, region, and age. 3. The order of magnitude of these variations in the different parts of the algæ, in the same species. It is proposed, in the year 1922, to carry out (1) more extended visits of inspection, with the object of determining the conditions of periodicity

of the harvesting, without injury to the field of algæ; also (2) the application of analytical methods to fresh algæ *in situ*; the determination of the iodine in exact figures; the comparison of the percentages of iodine, ash, tannic acid, reserve hydrocarbons, cellulose, and pigments.

E. S. G.

**Mediterranean Algæ.**—H. E. PETERSEN (*Report Danish Oceanogr. Exped.* (1908–10) *to the Mediterranean*. Edited by J. Schmidt. II. Biology. Copenhagen, 1918, 3, 1–20, 11 figs.; see also *Bot. Centralbl.*, 1919, 141, 279). A list of 123 species from 21 Mediterranean stations. Only the few dredgings from the Tunis coast and from the Ægean Sea yielded any good geographical information. *Ceramium brevizonatum* is described as new. Critical remarks and figures are appended to several species. About 35 species are recorded for the Ægean for the first time.

A. G.

**Study of the Algal Associations of San Juan Island.**—WALTER L. C. MUENSCHER (*Puget Sound Marine Station Publications*, 1915, I., 59–84, 6 pls.). The rocky shores of San Juan Island possess a very dense algal flora; but the sandy beaches and bays are almost devoid of algæ. Four distinct associations are to be noted as one descends from high-tide level to the *Nereocystis* beds—namely, the (1) *Endocladia* association; (2) *Fucus* association; (3) *Ulva* association; (4) Laminariaceæ association; and (5) *Zostera* association (in the shoal-water of bays). The number of species common to each association increases in the lower associations, and the algæ are larger in the lower associations. Red, brown, and green algæ are found in each of the four associations. Rhodophyceæ are found almost equally distributed in the different associations. Phæophyceæ are most abundant in species in the Laminariaceæ association. Chlorophyceæ are most abundant in the *Ulva* association. Myxophyceæ are represented by only a small number of marine species.

A. G.

**Ability of Seaweeds to withstand Desiccation.**—WALTER L. C. MUENSCHER (*Puget Sound Marine Station Publications*, 1915, I., 19–23). An account of experiments made with thirteen species (here arranged as they approximately occur in order of succession, from dry land down to low tide line):—*Gloiopeltis furcata*, *Fucus evanescens*, *Gigartina mamillosa*, *Colpomenia sinuosa*, *Rhodomela larix*, *Porphyra perforata*, *Halosaccion glandiforme*, *Iridæa laminarioides*, *Ulva lactuca*, *Sarcophyllis californica*, *Alaria valida*, *Desmarestia aculeata*, *Nereocystis Luetkeana*. The order is somewhat altered in the table which shows their ability to withstand desiccation; but as a general rule those species which grow highest above low tide level can stand the most desiccation, and those near the low tide level are the least resistant. It is a question of actual resistance to desiccation; and wave-action is not a factor in the situation of the plants. Ability to withstand desiccation may not be the only reason why some species grow high above low tide level, but drought is certainly one of the causes preventing certain species from growing much above low tide level.

A. G.

**Winter Condition of some Puget Sound Algæ.**—ANNIE MAY HURD (*Puget Sound Marine Station Publications*, 1917, I., 341-7). The winter flora does not differ much from that of summer. In spring the young forms of summer species appear. Some summer species of the Atlantic coast are present in Puget Sound all the winter. Conspicuous seasonal (summer) algæ are *Nereocystis*, *Costaria*, *Laminaria bullata*, *L. saccharina*, *Soranthera ulvoidea*, *Desmarestia aculeata*, *Scytosiphon lomentarius*, *Odonthallia floccosa*. Young plants of some species occur during the winter, but become much more abundant in March. Many red algæ reproduce all through the winter. *Fucus* plants remain sterile until February. *Agardhiella*, *Polysiphonia* and other red algæ produce both sexual and asexual spores all the winter, though on the Atlantic coast they are reported to pass through these generations at distinct seasons. In the case of *Polysiphonia californica* the carposporic plants are more abundant towards the end of winter, suggesting a partial seasonal separation between the two generations. A. G.

**Experiments with Marine Algæ in Fresh-water.**—LOLA B. BROWN (*Puget Sound Marine Station Publications*, 1915, I., 31-4, fig.). The results show that *Enteromorpha intestinalis* can live and grow up for five weeks in fresh-water, and probably it would occur in fresh-water but for the bacteria. Certain brown algæ common in the district were killed by fresh-water in a few days. Other algæ showed slightly more endurance. A. G.

### Fungi.

**Wart Disease of Potato.**—(*Weekly News Letter*, Washington, 1921, 8, No. 30, 3). The writer announces that the wart disease caused by *Synchytrium endobioticum* also attacks tomato plants. The disease, well-known in Europe, was discovered in America in 1918. Out of twenty-eight varieties of tomatoes planted in wart-infested gardens in Eastern Pennsylvania twenty-six were found to be susceptible to the disease. A. LORRAIN SMITH.

**Mycoplasma Theory**—is it dispensable or not?—JAKOB ERIKSSON (*Phytopathology*, 1921, 11, 385-8). Eriksson discusses the arguments adduced by various workers to account for the propagation of rust without having recourse to the mycoplasma theory. He also answers objections that have been brought forward against his views, more especially as to the presence of mycoplasma in potatoes infested with *Phytophthora*. He gives also an account of the stages through which mycoplasma passes before becoming mycelium in spinach mildew. A. L. S.

**Fusarium cubense Hyphomycete injurious to Banana in the Philippines.**—H. A. LEE and F. B. SERRANO (*Philipp. Agric. Bureau, Manila*, 1920, 13, 128-9; see also *Bull. Agric. Intell. Rome*, 1921, 12, 511-2). A banana wilt at Porto Rico had already been proved to be caused by *Fusarium cubense*. The authors have investigated a similar wilt in the Philippines, and have isolated a *Fusarium* which corresponds with *F. cubense*. The Latundan variety of the banana (*Musa sapientum*) is the only one found to be susceptible so far. A. L. S.

**Uredinales collected by Fred J. Seaver in Trinidad.**—J. C. ARTHUR (*Mycologia*, 1922, 14, 12-24). The list consists of seventy-one species collected during a six weeks' visit to the island. Several species are new to science. An index of the species and of the host plants is appended. A. L. S.

**Life of Puccinia Malvacearum Mont. within the Host Plant and on its Surface.**—JAKOB ERIKSSON (*Phytopathology*, 1921, 11, 459-63). The author states that watering the soil with fungicides is harmful to the fungus. He describes the germination of two types of spores:—(1) Autumn spores, which in moist air form promycelia and sporidia, but under water germinate with long straight tubes, which at the tip liberate conidia, arranged like a string of beads; (2) Summer spores, which occur from May to July, and germinate in all cases with long straight tubes bearing conidia. The sporidium attacks the host by penetrating the epidermis. The conidium infuses its contents as plasm into the epidermal cell; the plasm penetrates the tissue of the host and constitutes a mycoplasm. A. L. S.

**Diagnoses of American Porias: I.**—L. O. OVERHOLTS (*Mycologia*, 1922, 14, 1-11, 1 pl.). Three species have been fully redescribed and illustrated by the author. They are: *Poria nigrescens*, *P. ferruginosa* and *P. ambigua*; they are European species that occur also in America. A. L. S.

**Mycological Notes.**—A. VAN LUYK (*Med. Van Rijks Herb.*, 1919-21, 39, 1-10, 10 figs.). This paper deals with the Geoglossaceæ of the Reich Herbarium at Leyden. The writer gives notes on *Mitrula* (two species), *Microglossum olivaceum*, *Corynetes arenarius*, nine species of *Geoglossum*, *Trichoglossum hirsutum*, and two species of *Cudonia*. He discusses the characteristics and nomenclature of the various species. A. L. S.

**Longevity of certain Species of Yeast.**—ARTHUR R. LING and DINSHAW RATTONJI NANJI (*Proc. Roy. Soc.*, 1921, 92, 355-7). The species of yeast were contained in tubes plugged with cotton wool and covered with sealing wax. They dated from 1887. It was found that all the eight cultures were living; it was not possible to determine whether they had persisted as resting cells or as spores. A. L. S.

**Fungi Ascomycetes, Ustilaginales, Uredinales.**—DAME HELEN GWYNNE-VAUGHAN (*Cambridge University Press*, 1922, 232 pp., 196 figs.). This volume of Botanical Handbooks deals, as the title tells, with only some of the chief groups of Fungi, but there is a general introduction to the whole class which describes the vegetative structures and discusses Saprophytism, Parasitism and Symbiosis. There is also a section devoted to some aspects of the physiological problems such as Chemotropism, Hydrotropism, etc. The first thirty-one pages are given to these general subjects. The special study of Ascomycetes—Plectomycetes (a new classification), Discomycetes and Pyrenomycetes—follows, and necessarily deals largely with their cytology. This subject is very fully described for the many different forms—primitive and

advanced—and the statements made are abundantly illustrated. Plectomycetes and Discomycetes are treated first, then Pyrenomycetes in the same exhaustive way. Two other groups—Ustilaginales and Uredinales—are similarly examined and described. A bibliography dealing with the special subjects is appended to each chapter, and a copious index completes the book.

A. L. S.

**Orchid Mycorrhiza.**—J. RAMSBOTTOM (*Charlesworth and Co.'s Catalogue*, 1922, 1-18, 3 pls.). A general account of symbiosis between fungi and other plants is given first. That fungi were present in the rootlets of *Phanerogams* has been known for a long time. Link figured them in an orchid in 1840. The paper before us deals mainly, however, with the obligate association between germinating orchid seeds and the mycelium of a fungus. They were first discovered in the roots in 1847. Their occurrence there is described, and then the germination of the seeds, which were known not to grow unless on "orchid soil." It is necessary only to supply the fungus, which was done on a commercial scale and with scientific exactness by the late Joseph Charlesworth (1851-1920). The special fungus required is discussed, and is referred for convenience to the genus *Rhizoctonia*. The dependence of *Gastrodia elata* on a fungus (*Armillaria mellea*) is described, and the question of seed production in orchids is discussed. Mycorrhiza in Ericaceæ and Pyrolaceæ has been thoroughly examined by various workers and the results are given, and there is a general account of Saprophytism in relation to the association of Mycorrhiza with so many different types of plants.

A. L. S.

**Mycological Contributions.**—KARL KAVINA (*Vestník Králov. České Společnosti Nauk*, 1917, 4, 1-21, 3 figs.). The author describes a new species parasitic on moss, *Tricothecium bryophilum*. He found it in several localities both in the open and in glass-houses, and on several different mosses. Another new fungus, *Eurotium Velichii*, with very dark spores, was found on the soil, possibly on rotting vegetation. The perithecia were easily developed in culture. Notes are given on *Podophacidium terrestre*, which he has proved to be identical with *Melachroia xanthomela*. He found the different stages of the fungus growing in the open. The species now takes the name *Podophacidium xanthomelum*.

A. L. S.

**Higher Basidiomycetes from the Philippines and their Hosts: V.**—OTTO A. REINKING (*Philippine Journ. Sci.*, 1921, 19, 91-114). The list of fungi, Auriculariaceæ, Polyporaceæ, &c., is a continuation of those previously published; the majority of the determinations were made by C. G. Lloyd. Under each species the host or substratum is given, and, as an appendix, a list of hosts with the fungi that have been found on them. Some of the fungi—as, for instance, *Auricularia Auricula-Judæ*—have been found on a very large number of trees.

A. L. S.

**Illustrations of Fungi: XXXIII.**—WILLIAM A. MURRELL (*Mycologia*, 1922, 14, 25-9, 8 pls.). The author has described at length

eight species of Agaricaceæ, and has illustrated them by photographs from the fresh specimens. Several are European, others known only from the United States. A. L. S.

**Philippine Basidiomycetes: IV.**—PAUL W. GRAFF (*Torrey Bot. Club*, 1921, 48, 286-95). The author states "that the fungous flora of the tropics is proving to be much more extensive than had previously been imagined." In this paper he deals entirely with Polyporeæ, and the list contains some rare and interesting records, though none of those described are new to science. A. L. S.

**Mycorrhizas of *Pinus silvestris* and *Picea alba*.**—ELIAS MELIN (*Journ. Ecology*, 1922, 9, 254-7). The author has published as a preliminary note an account of work done by cultures with ectotrophic Mycorrhizas. He has isolated and tested three forms of mycelium from *Pinus silvestris* and one from *Picea*. In addition a dark coloured mycelium which attacks the seedlings parasitically was also grown. The mycorrhizal fungi are aerobic organisms which grow more vigorously in an acid substratum. Organic nitrogen compounds form a more valuable source of nitrogen for these fungi than inorganic ones. Preliminary experiments indicate that at least the Mycorrhizas of *Pinus silvestris* fix the nitrogen of the air. The author dissents from MacDougal's view that the tree is not benefited by association with the fungus. A. L. S.

**European Canker on the Pacific Slope.**—S. M. ZELLER and C. E. OWENS (*Phytopathology*, 1922, 11, 464-8, 4 figs.). Canker on apple due to the fungus *Nectria galligena* has been reported from several localities in Oregon and California. Many varieties of apple-trees have been attacked. The author describes the fungus, and illustrates the damage done to branches and stems by photographs of the diseased areas. The mycelium of the fungus penetrates the tissues and destroys the cambium. A. L. S.

**Septogloeum Arachidis, Leaf-spot of the Peanut in South Africa.**—VAN DER BIJL (*Union of South Africa Journ. Dept. Agric.*, 1920, 1, 528-30, 2 figs.; see also *Bull. Agric. Intell. Rome*, 1921, 12, 364-5). In South Africa, especially along the coastal region of Natal, the peanut is often attacked by *Septogloeum Arachidis*, which forms circular or irregular black spots on leaves and stems. The diseased leaves wither and fall off. Various methods of treatment for the disease are recommended. A. L. S.

**Decay of Brazil Nuts.**—EDWIN ROLLIN SPENCER (*Bot. Gaz.*, 1921, 72, 205-92, 5 pls., 3 figs.). Brazil nuts suffer in transport and in storage from the attack of fungi and bacteria. The writer of the paper has succeeded in isolating seven distinct organisms, and describes their development and their effect on the nuts. Fully 5 p.c. of all diseased nuts are affected with a black crust on the endosperm, which bears pycnidia and colourless simple spores. He names this fungus *Pelionella macrospora*. A white mould, less frequent but very pernicious, was determined as *Cephalosporium bertholletianum*; the mycelium of the

mould penetrates and destroys the radicle of the nut. A disease called dry-rot is shown by a mottled appearance of the shell, the inside being filled with the mycelium of a *Fusarium*. Many nuts are destroyed by *Aspergillus flavus*: the kernel shrinks, often cracks, and is always covered by a mass of dark brown spores. In addition to these fungi, Spencer isolated and cultured a *Bacterium* sp. *Actinomyces brasiliensis* sp. n., which destroys the nuts. He describes finally a decay due to *Phomopsis berthollettianum* sp. n., and notes the presence of a *Myxosporium* which causes bitter rot. A. L. S.

**Onion Smut.**—T. WHITEHEAD (*Journ. Board Agric.*, 1921, 28, 451-5). An account of experiments to combat the disease is given in detail. The most effective treatment is undoubtedly the application of formaldehyde to the open drill, which prevents any spores present in the soil from germinating and so infecting the onion seed. An explanation of the methods employed is given. A. L. S.

**New Disease of Dates.**—EDM. SERGENT and M. BÉGUET (*Comptes Rendus*, 1921, 172, 1624-7). The disease is called by the natives "baïoudh"; it is spreading in the Moroccan oases, and threatens to do much damage. Examinations and experiments have been made, and the disease has been found to be caused by a fungus which resembles *Neocosmospora vasinfecta*, a pathogenic organism. The reproduction of the disease by infecting healthy date-trees is to be attempted. A. L. S.

**Pathology of *Lupinus arboreus*.**—ARTHUR S. RHOADS (*Phytopathology*, 1921, 11, 389-404, 3 pls.). The shrub *Lupinus arboreus*, the tree Lupine, is of common occurrence in America, on sandy soils near the ocean, and is economically of considerable importance as a soil retainer in sand dune country. It is subject to rotting caused by two wound parasites, *Collybia velutipes* and *Pleurotus ostreatus*, which are normally saprophytic fungi. The wounds of the bush plants are made by the larvæ of a moth. The fungus destroys the cellulose layers bordering on the lumina of the wood fibres; the dissolution starts at the lumen and progresses towards the middle lamella, the dissolution of the lignified members follows. A. L. S.

**Resistance of Barley to *Helminthosporium sativum*.**—H. K. HAYES and E. C. STAKMAN (*Phytopathology*, 1921, 11, 405-11). The authors describe the breeding experiments undertaken to secure a race resistant to spot-blotch diseases. A certain amount of success has been obtained. A. L. S.

**Violet Root Rot (*Rhizoctonia crocorum* DC.) in the United States.**—JAMES A. FARIS (*Phytopathology*, 1921, 11, 412-23). Specimens of potatoes covered with a violet felt of mycelium were sent to the University of Nebraska. The disease is of minor importance, but may become serious and be propagated by infected tubers. Experiments are desirable to find if the fungus is identical with the one that attacks alfalfa and sugar beets. The effect of the fungus on the tubers is to break the periderm and so induce drying out of the potato in storage. The fungus forms small cushions below the epidermis which burst through and cause the breaks. A. L. S.

**Ophiobolus causing Take-all of Wheat.**—H. M. FITZPATRICK, H. E. THOMAS and R. S. KIRBY (*Mycologia*, 1922, **14**, 30-7, 1 pl., 1 fig.). The minute Pyrenomycete causing a disease known in Europe and Australia, and now discovered in America, is identical with *Ophiobolus graminis* and with a previously described *Sphæria cariceti*. The authors describe its occurrence on the host plants (wheat, barley, rye and various wild grasses). The mycelium permeates the roots of the host. The perithecia develop on the crown of the plant. A. L. S.

### Lichens.

**Notes on Lichens from Jamaica.**—CHARLES C. PLITT (*Bryologist*, 1921, **24**, 60-4). The writer spent six weeks at the Government Laboratory on the summit of Cinchona Hill, Jamaica. He devoted his attention chiefly to lichens, and collected during that time about 200 different lichen species. He comments on the wealth of material and the luxuriance of the plants, and gives an account of the conditions of terrain and of climate that favour lichen growth. He concludes that lichens are peculiarly sun plants, as they were much less abundant in shaded areas. The competition for place between the different forms was very keen, but lichens, he found, held their own in the struggle. "*Sticta* and *Leptogium* species especially spread their thalli with the least unconcern over hepatics and mosses." A first account is given of the fruticose forms and of the many *Cladoniæ*. He also found *Sphærophorus compressus* varying in colour from coral-red to almost pure white.

A. LORRAIN SMITH.

**Thallus of the Genus *Parmelia*.**—JOHN SHIRLEY (*Proc. Roy. Soc. Tasmania*, 1919, 53-68, 5 pls.). The author gives a general account of structure, noting especially the presence of spores or of openings in the thallus; he has concluded from experiments he has made that the cyphellæ of *Stictaceæ*, etc., are not only for aeration but are means whereby water and food pass into the tissues. He has also given attention to the hyphæ, the cortex and the rhizoids. He traces the connexion of *Parmelia* with other genera, and considers that *Sticta* and *Lobaria* should form part of the *Parmeliaceæ*. The plates give photographic illustrations of structure, of the pores to be found in *Parmelia*, of spermagonia, and of apothecia.

A. L. S.

**Destruction of Mosses by Lichens.**—FRANK P. McWHORTER (*Bot. Gaz.*, 1921, **72**, 321-5, 1 pl.). The writer proposes to emphasize the accuracy of Bruce Fink's definition of lichens:—"A lichen is a fungus which lives during all or part of its life in parasitic relation with an algal host, and also sustains a relation with an organic or inorganic substratum." He gives the case of various lichens—*Cladoniæ*, *Physciæ*, *Amphiloma*, etc.—that overrun and destroy moss colonies. The destruction he found was partly due to parasitism and partly to smothering. The development of lichens over the mosses explains the ecological sequence of first mosses, then lichens.

A. L. S.

**Japan Lichens.**—E. A. WAINIO (*Bot. Mag. Tokyo*, 1921, **35**, 45-79). The lichens here listed and described were collected by A. Yasuda

in various provinces of Japan. They number 181, to which is added one fungus, a *Leptosphaeria*. Wainio has found many new species in the material, among them three species of *Melanaspicilia*, a genus that bears the same relationship to *Physcia* or to *Rinodina* that *Aspicilia* bears to *Lecanora*. The other genera are familiar to European lichenologists. The paper is a continuation of one published in the same journal (1918, 32, 154-63).  
A. L. S.

**New Japanese Lichen Species.**—ATSUSHI YASUDA (*Bot. Mag., Tokyo*, 1921, 35, 8). A separate notice is given of these lichens, but the full descriptions are printed in Wainio's paper; they are species of *Ochrolechia*, *Lecanactis* and *Polyblastia*.  
A. L. S.

**Different Forms of Lichen Symbiosis in *Solorina saccata* and *S. crocea*.**—M. and MADAME MOREAU (*Rev. Gén. Bot.*, 1921, 33, 81-7, 1 pl.). The authors have studied the problem of symbiosis between fungus and alga in the cephalodia of these two lichens. In *Solorina saccata* are found external cephalodia on the lower surface of the thallus. Algae, other than those normal to the thallus, with which the thallus may come in contact are left intact, but if *Nostoc* algae are encountered, the lichen hyphae grow out and surround the algal cells, thus forming a small tubercle. These tubercles are considered by the authors to be of a gall nature. In some instances the alga is drawn deeper into the tissue, and an internal cephalodium arises. In *Solorina crocea* the alien *Nostoc* algae form a layer beneath the normal gonidial layer of bright green cells; it is an extended cephalodium. As in these cephalodia dead algae are frequent, the authors trace a development from pathological conditions to symbiosis, but claim that the research has confirmed their view as to the general pathological character of lichen symbiosis.  
A. L. S.

### Mycetozoa.

**Preliminary List of the Myxomycetes of the Cayuga Lake Basin.**—F. B. WANN and W. C. MUENSCHER (*Mycologia*, 1922, 14, 38-41). The territory from which the Myxomycetes were collected is situated in Central New York State. The list includes 92 species in 30 genera and 11 families.  
A. LORRAIN SMITH.

**Mycetozoa Found During the Minehead Foray.**—G. LISTER (*Trans. Brit. Mycol. Soc.*, 1921, 7, 10-12). A list of forty-nine species is given, a good average result for the time and the district. One of the most notable finds was *Cribraria pyriformis* on sawdust heaps, a rare species in England, though frequently found in Scotland.  
A. L. S.

**Mycetozoa at Porlock in October 1920.**—NORMAN G. HADDEN (*Trans. Brit. Mycol. Soc.*, 1921, 7, 13-16). Hadden writes this paper as a supplement to the account of the Minehead gatherings. In October the weather had become moist and favoured the development of many more species than had appeared at the date of the Minehead foray. He gives descriptions of most of these, noting especially the

appearance and growth of the plasmodia. He also found about thirty sporangia of the remarkable *Diachæa cerifera* hitherto only found in Norway, Switzerland and Japan.

A. L. S.

**French Flora of Myxomycetes.**—S. BUCHET, H. CHERMEZON et F. EVRARD (*Bull. Soc. Mycol. France*, 1920, **36**, 106–20). The authors propose to prepare a Flora of these organisms for France. In this second article on the subject they give notes on herbarium specimens and records of French species. They also give recently published lists from various localities, and a first supplement to the list for France as a whole.

A. L. S.

## MICROSCOPY.

## A. Instruments, Accessories, etc.

**Special Oil-immersion Objectives for Dark-field Microscopy.**—SIMON H. GAGE (*Science, N.S.*, 1921, **54**, 567–9). The author reviews the pioneer work of Joseph Jackson Lister (1830), the Rev. J. B. Reade (1837), F. H. Wenham (1850–56), and Dr. James Edmunds (1877) in dark-field microscopy. This work was published in Transactions of the Royal Society, 1830; Trans. Micr. Soc. of London, and Quart. Jour. Micr. Science, 1850–56; Jour. Quek. Micr. Club, and Month. Micr. Jour., 1877; Quekett's "Treatise on the Microscope," 1848–55; and Carpenter's "The Microscope and its Revelations," 1856.

He points out the two essentials for dark-ground microscopy:—(1) A very brilliant light is needed. Full sunlight was recommended and remains the most satisfactory light, although the newly-devised electric lights like the small arc lamp and the low-voltage head-light lamps serve very well. (2) The large aperture of high-power objectives, especially those of the immersion type, which are a necessity with the most exacting work, must be overcome, because dark-field condensers cannot be constructed with high enough aperture to give a dark-field with these high-power objectives. In this connexion two courses are open: (*a*) to so construct high-power objectives that the aperture was low enough to give dark-field effects with the dark-field condensers practicable to construct; or (*b*) to introduce into the high apertured objectives a diaphragm to cut down the aperture.

The second course was that usually adopted, and reducing diaphragms of all kinds, with apertures varying from 0.40 to 0.90 N.A., have been met with, but in many cases they were so constructed that they were liable to get out of place, get out of the optic axis, and prove generally unsatisfactory.

After a full examination of the different dark-field condensers made it seemed that the best all-round objective to use with them would be about 0.80 N.A. Such an aperture would give a good dark-field with all the standard dark-field condensers, and this aperture is great enough to give good resolution on the one hand and the needed brilliancy on the other.

He therefore appealed to the American manufacturers of microscopic objectives to design and manufacture oil-immersion objectives of this aperture (0.80 N.A.). During the past summer and autumn the Bausch and Lomb Optical Company, of Rochester, N.Y., undertook the manufacture of the desired medium-apertured oil-immersion objectives. The outcome is all that could be asked, and these objectives are now available.

The Spencer Lens Company, of Buffalo, also manufacture a 1.8 mm. oil-immersion of 0.85 N.A. for dark-field work. Both firms supply these special objectives at the same price as their regular oil-immersion objectives.

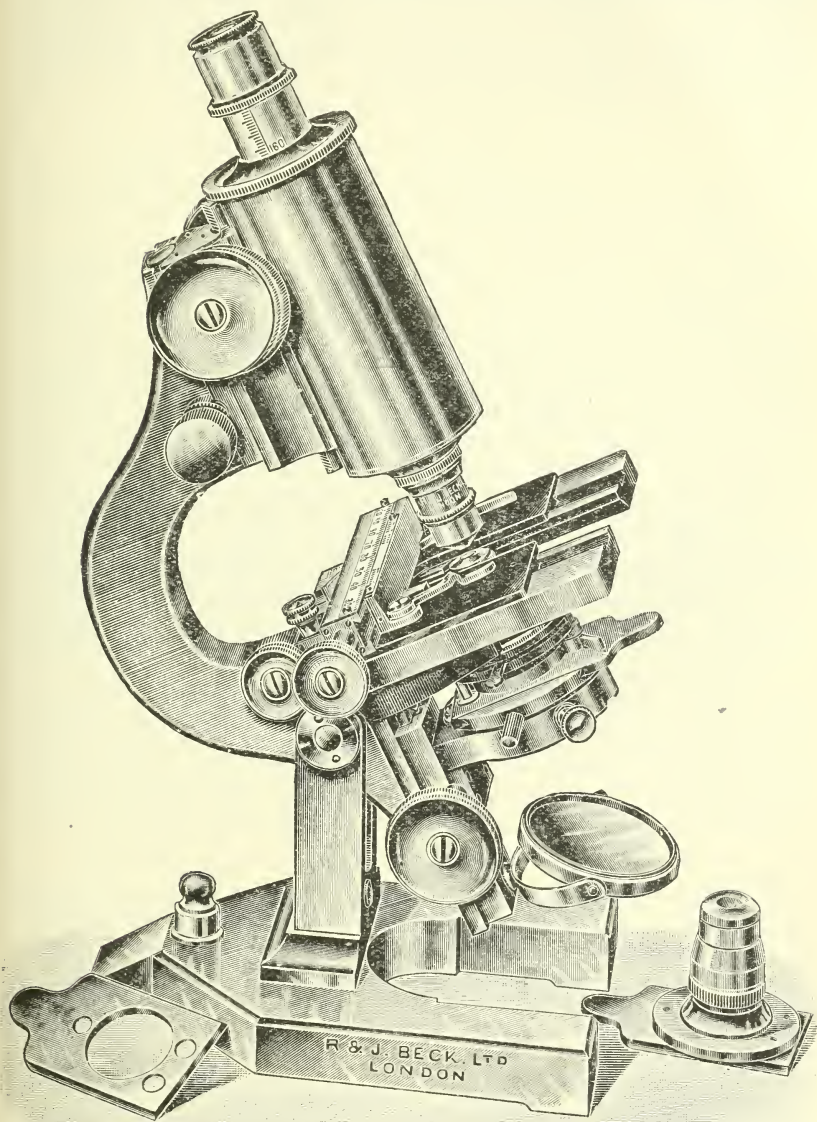
It may be stated in passing, with reference to these new objectives, that they have certain advantages for ordinary bright-field work. As ordinarily employed the oil-immersion objective of high aperture (1.40

to 1.20 N.A.) is used in bright-field work without oil-immersion contact between the under-surface of the slide and the top of the bright-field condenser. As the light of an aperture greater than 1.00 N.A. cannot emerge from the condenser into air, it follows that not nearly all of the available aperture is employed. Of course when the resolution of fine details is involved the higher aperture is of great importance, but in order to be fully utilized the microscope slide must be in immersion contact with the top of the condenser.

**A New Form of Interferometer.**—H. P. WARAN (*Proc. Roy. Soc., Series A*, **100**, 1922, *A705*, 419). Instead of a thin plate of glass with its two surfaces worked optically true and parallel to one another, as in the Lummer and Gehrke interferometer, the author has devised an apparatus in which a thin layer of one liquid (water) floats on a layer of another liquid (mercury), thus adopting an idea which was used by the late Lord Rayleigh. Great trouble was experienced from earth-tremors, and extraordinary precautions were necessary to eliminate them, but in the end all difficulties were surmounted. The source of light used was that of a glass mercury-vapour lamp filtered through a green filter to get the intense monochromatic radiations of wave-length  $5460.7 \text{ \AA.U.}$  Analysis of the light transmitted by this filter showed that the two yellow lines were still present faintly, while the other lines were practically eliminated. Lamps of convenient form were successfully constructed by the author. The trough, which contains the interferometer liquids, is a closed rectangular vessel,  $40 \times 10 \times 6 \text{ cm.}$  in size. One end is formed by a prism of equilateral section, attached to the sides of the trough, with one of its surfaces inclined at an angle of  $13^\circ$  (for water) to the vertical. The collimated beam, which is reflected upwards, enters the first face of the prism normally, and after total reflection at the second face enters the liquid after passing out normal to the third face. The beam of light is successively reflected at the upper and lower surfaces of the water layer, and on emergence through a thin mica window is caught in a telescope and examined for the formation of the system of interference bands. It is advantageous to have the individual bands widely separated to secure high resolving powers, and hence the thinner the water layer the better. The fringes were found to be remarkably sharp on quiet days. A. N. D.

**The Massive Model Microscope.**—This instrument, which was designed for the National Institute of Medical Research, is of a more massive and solid design than has hitherto been attempted in microscope construction. This, combined with extreme delicacy in the adjustments, enables it to be used with high powers with almost complete freedom from flexure and the effects of vibration. The limb is a massive brass casting with a machined fitting for the slow motion at one end and a dovetailed fitting for the substage apparatus at the other end. The stage is a heavy casting with side brackets below fixed rigidly and permanently to the limb, so that the whole forms one solid element. The pillar and base are very heavy and rigid, and a short post on the base forms a rest for the limb when it is placed with the body in a horizontal position for photo-micrography. The substage has focusing

and centring adjustments, and at its upper end is provided with a dove-tailed fitting to receive condensers and dark-ground illuminators, on the



plan devised by Mr. Akehurst. All illuminators are supplied fixed to slides which run loosely into the dovetail, and are clamped in position

by a screw, and the front of the stage is cut away to enable them to be changed without shifting the focus of the substage. All condensers and illuminators are parfocal and centred to a standard, so that changes in the illumination can be accurately and rapidly made. The mechanical stage is double as fine in its motion as the usual type, and has horizontal travel of 3 in., and the fine adjustment is exceptionally delicate, each division of the milled head being equal to 0.001 mm.

#### Microscopic Optics.

- MANGUIN, CH.—Utilisation possible des diagrammes de diffraction des rayons X pour la détermination complète de la structure du quartz. (*Comptes Rendus*, 1921, **17**, 719.)
- DE BROGLIE, MAURICE.—Sur les spectres corpusculaires et leur utilisation pour l'étude des spectres de rayons X. (*Comptes Rendus*, 1921, **23**, 1157.)
- PEREIRA-FORJAZ, M. A.—Étude spectrographique d'une météorite portugaise. (*Comptes Rendus*, 1921, **23**, 1170.)
- PEREIRA-FORJAZ, M. A.—Étude spectrographique des minéraux portugais de tungsten. (*Comptes Rendus*, 1921, **23**, 1170.)
- SIEGBAHN, M.—Nouvelles mesures de précision dans le spectre de rayons X. (*Comptes Rendus*, 1921, **25**, 1350.)
- DE BROGLIE, LOUIS.—Sur la théorie de l'absorption des rayons X par la matière et le principe de correspondance. (*Comptes Rendus*, 1921, **26**, 1456.)
- DUFOUR, MARCEL.—Relation entre l'aberration et l'astigmatisme pour un point situé sur l'axe d'un système optique centré. (*Comptes Rendus*, 1922, **5**, 288.)
- COSTER, M. D.—Sur la série L du spectre des rayons X. (*Comptes Rendus*, 1922, **6**, 378.)

#### GEOLOGY, ETC.

Primary Zones of Cornish Lodes.—E. H. DAVISON (*Geological Mag.*, Nov. 1921). Microscopic work has resulted in the view that the primary minerals in the Cornish veinstones occur in zones which change their character in depth: thus copper minerals give place to cassiterite (tin) on passing down the lode, and chlorite gives place to tourmaline.

F. I. G. R.

Dolomitization in Carboniferous Limestone.—L. M. PARSONS (*Geological Mag.*, Feb. 1922). A number of microphotographs illustrating various stages in the dolomitization process are given, from which the complex character of the material is evident.

F. I. G. R.

Interference Fringes and Focal Length of Objectives.—F. I. G. RAWLINS (*Phil. Mag.*, April, 1922). A logarithmic formula is deduced for Groth's function.

**Determination of Optic Axes from Extinction Angles.**—H. HILTON (*Mineralogical Soc.*, Nov. 1, 1921). By using the extinction-directions on four known faces of a crystal the position of the optic axis is obtained. From a geometrical standpoint the solution is shown to be unique.  
F. I. G. R.

## METALLOGRAPHY, Etc.

**Electro-deposited Iron and Effect of Acid.**—W. E. HUGHES (*Trans. Faraday Soc.*, 1922, 17, Part 2). After giving details of the method of electro-deposition, the author proceeds to the microstructure of the deposit. He gives a remarkable photomicrograph showing the appearance during the two periods considered; also the effect, under very high magnification, of the characteristic copper film. Two types of structure are recognized, "normal" and "fibrous," and the connexion between them is traced. An illustration of the influence of acid concludes the paper.  
F. I. G. R.

**High Temperature Phenomena of Tungsten Filaments.**—C. J. SMITHELLS and OTHERS (*Trans. Faraday Soc.*, 1922, 17, Part 2). Two types of tungsten wire are used for lamp filaments—(1) Pure tungsten; (2) tungsten + refractory oxide. The deformation of the filament is found to be a function of crystal growth. Numerous photomicrographs accompany the paper.  
F. I. G. R.

**Recrystallization of Cu-Zn Alpha Solid Solution.**—M. COOK (*Trans. Faraday Soc.*, 1922, 17, Part 2). The author describes the behaviour of an unworked alpha brass, containing 30 p.c. Zn, 70 p.c. Cu. An interesting photomicrograph shows that twin crystals can be produced in a casting annealed at 825° C., no previous work having been done upon the specimen.  
F. I. G. R.

**Inner Structure of Pearlite Grain.**—N. T. BELAIEV (Iron and Steel Institute Meeting, May, 1922). The author sets out to investigate a series of iron-carbon alloys, subjecting them to extremely slow rates of cooling. By this means he develops the pearlite to as coarse a degree as possible; in some cases this constituent is relatively so large as to be visible with a magnification of 30 to 50 diameters. Many workers have noticed the peculiarity that the fineness of the pearlite varies considerably in different crystal grains of the same sample. This paper endeavours to show how the appearance of pearlite is influenced by the direction in which the section is made. Data (and some very interesting illustrations) are given for a number of different angles of inclination. The author also gives the results of his micrometric observations on the width of the lamellæ. Following Prof. Arnold much stress is laid on a correct understanding of the "solid geometry" of steel.  
F. I. G. R.

**Hydrogen Decarbonization of Carbon Steels.**—C. R. AUSTIN (Iron and Steel Institute Meeting, May, 1922). A discussion of the influence of time and temperature on the rate of decarbonization by hydrogen of carbon steels. A very complete set of photomicrographs show how the temperature affects the microstructure of the partly decarbonized steels. The influence of time (at constant temperature) is also considered. The crystal structure of the carbon-free periphery is investigated, and a theory brought forward as a possible explanation of the "columnarization" phenomenon. The rate of diffusion of carbon, or iron-carbide, in iron is considered—based on Fick's Law.  
F. I. G. R.

**Effect of Oxidizing Gases at Low Pressures on Heated Iron.**—H. C. H. CARPENTER and C. F. ELAM (Iron and Steel Institute Meeting, May, 1922). Of chief interest to microscopists is the remarkable series of photomicrographs exhibited in this paper. The illustrations of Armco iron heated in vacuo and electrolytic iron after heating are exceptionally interesting. Seldom has the characteristic crystalline habit of iron been more perfectly shown. The samples in question were heated from below 900° C. to above 1000° C. in an evacuated quartz tube.  
F. I. G. R.

**Delayed Crystallization in Carbon Steels**—A. F. HALLIMOND (Iron and Steel Institute Meeting, May, 1922). Recent research on quenching has demonstrated the necessity of considering the growth of structures, such as martensite and troostite, which have no counterpart among those formed under "reversible" conditions to which the common theories holding in physical chemistry can be applied. In these irreversible cases it is essential to take account of "delayed crystallization." In considering the rate of cooling, and its influence upon microstructure, the following points are important:—1. The existence, below the ordinary solubility curve for each constituent, of a range of temperature and concentration within which crystallization is only initiated upon the introduction of a suitable nucleus. 2. The rate of growth of a crystal first increases as the temperature falls below that of equilibrium, and then diminishes. 3. The redistribution of heat and dissolved matter.  
F. I. G. R.

**Dissolved Oxides in Steel.**—E. W. EHN (Iron and Steel Institute Meeting, May, 1922). The influence of oxides is explained theoretically. A series of photomicrographs accompany the paper.  
F. I. G. R.

**Formation of Globular Pearlite.**—J. H. WHITELEY (Iron and Steel Institute Meeting, May, 1922). The author shows that the carbide constituent of pearlite does not dissolve completely at the transformation A<sub>1</sub>C<sub>1</sub>. Globular pearlite can be formed in hypoeutectoid steel at a temperature 15° to 20° higher than lamellar pearlite. An excellent series of microphotographs show instances of globular and lamellar pearlite existing together, and also globular pearlite starting to form.  
F. I. G. R.

## ULTRAMICROSCOPY, COLLOIDS, ETC.

**Solubility of Small Particles and Stability of Colloids.**—L. F. KNAPP (*Trans. Faraday Society*, 1922, **17**, Part 2). A theoretical paper of the greatest importance, in which the microscope plays a considerable part. A relation on thermodynamical grounds has already been obtained between solubility and size of solid particles. The stability of many colloids appears to be some function of the electric charge carried by the disperse phase. A mistake crept into the original mathematical analysis. The correct expression (Freundlich) is given in the present paper.  
F. I. G. R.

**Clays as Disperse Systems.**—SVEN ODÉN (*Trans. Faraday Society*, 1922, **17**, Part 2). According to the author, "clays are disperse formations of mineral fragments in which particles of smaller dimensions than  $2\mu$  predominate." The part played by the ultramicroscope in treating clays as colloidal systems is considered, and also the extension of researches to the question of sedimentation in more viscous liquids.

F. I. G. R.

**Plasticity of Clays.**—J. W. MELLOR (*Trans. Faraday Society*, 1922, **17**, Part 2). A workable definition is given, i.e.

$$\text{Plasticity} = \frac{\text{Cohesion}}{\text{Internal Friction}}$$

The author proceeds to discuss the property with reference to grain-size, colloidal clay, etc. An attempt to detect "L'argile colloïde" microscopically is described.

F. I. G. R.

## NOTICES OF NEW BOOKS.

**Critical Microscopy.** How to get the best out of a microscope. By Alfred C. Coles, M.D., D.Sc., etc. 1921. viii + 100 pp., 8 illustrations. Published by J. and A. Churchill, 7 Great Marlborough Street, London. Price 7s. 6d. net.

The author states that this small book may be regarded as a supplement to, rather than a substitute for, the many excellent works on the microscope now available; and it is written with the hope of assisting microscopists, whatever may be their special line of work, to get the very most out of their instrument.

The term "Critical Microscopy" is due to Mr. E. M. Nelson, and full credit is given to him for the methods described; the book in fact consists, in large part, of extracts from writings or from direct communications from Mr. Nelson. It opens with a description of an ordinary microscope, but no attempt is made to describe a number of types. The only one figured is the Service Microscope, made by Messrs. W. Watson and Sons, and as this does in fact represent a microscope made in this country for student's purposes at the present time, it may be regarded as typical. It is the design of stand recommended by the British Science Guild Committee on Microscopes, and has the particular advantage that it can at any time have added to it any additional appliance that may be needed for more advanced work.

The various types of objective are described, and the writer indicates those that are suitable for particular classes of work, rightly indicating that a large variety of objectives is by no means necessary. He further states that the use of apochromatic objectives is not essential for work even of the highest class, a point that every practised microscopist realizes. It is by no means now common to see a high-power apochromatic objective being used with an Abbe non-achromatized condenser of an ordinary type, the result being that the advantage of the apochromat is largely lost.

A suitable series of oculars is indicated, and preference is given to those of the compensating type, even in cases where achromatic objectives are used. The author also prefers a triple nose-piece rather than the sliding objective-changers as introduced by Zeiss. When the triple nose-piece is well enough made to ensure accurate centration and perfect alignment of optic axes no doubt it is satisfactory, but for some classes of accurate work it is probable that the sliding changers are to be preferred.

As an illuminant the paraffin lamp is recommended. A bull's-eye condenser is used in conjunction with this, and is fitted to the lamp as an integral portion of it, so that any alteration in the position of the lamp does not disturb the relation of the illuminant to the bull's-eye condenser.

The author's arrangement of lamp, screen-holder, eye-shade and microscope is figured, and is so arranged that the whole outfit is fixed to a board, ensuring the proper and constant relation of the various items.

The manipulation of the microscope and its accessories constitutes the larger portion of the book, and in that an exposition is given of the meaning of the term "Critical Microscopy" as laid down by Mr. Nelson.

One of the main adjustments in accurate work with the microscope is the proper determination of tube length under any given conditions. This is very fully dealt with, and the various known methods to correct for different thicknesses of cover-glass, or different types of objects, are well set out. Dark-ground illumination is also fully described, beginning with the method of placing a stop in an ordinary sub-stage condenser. Little consideration is given to the modern type of concentric dark-ground illuminator; in fact it is stated that the method of using a stop in a good sub-stage illuminator is superior in some respects to results obtained by using a concentric condenser, a statement that some, at least, may be inclined to controvert.

A description is given of a method of observing stained preparation by means of dark-ground illumination, a method that the author apparently claims as his own.

The care of the eyes is well dealt with, and it can be commended as one of the most useful sections, short as it is, in this book.

A brief account of the author's method of taking photo-micrographs, particularly that in which he takes a series on such a small size as a quarter-plate, is described. It would not be difficult to criticize many of the statements made in the book; at the same time, the obvious and expressed intention of the writer is to help those who have occasion to use the micrograph. There is no doubt that if the methods described are followed, a much higher order of work would be accomplished than if reliance is placed on the very haphazard methods at present practised in most laboratories. From this point of view, therefore, the book thoroughly justifies itself. It suffers somewhat from the frequent abstracts from letters and from other published papers, but in general it may be commended to the student or to the medical research worker as a useful guide.

J. E. B.

*Études sur les Infusoires d'eau Douce.* By Dr. E. Penard. 1922. 331 pp. Published by Georg and Cie, Geneva.

*A Handbook of the British Lichens.* By Annie Lorrain Smith, F.L.S. 1921. 159 pp. Published by the British Museum (Natural History), Cromwell Road, S.W.7.

*Catalogue of the Fossil Bryozoa (Polyzoa), in the Department of Geology, British Museum.* Vol. III. The Cribrimorphs, Part 1. By W. D. Lang, Sc.D., F.G.S. 1921. 269 pp. and 8 pls. Published by the British Museum (Natural History), Cromwell Road, S.W.7.

*Practical Plant Biology.* By Henry H. Dixon, Sc.D., F.R.S. 1922. xii + 291 pp. Published by Longmans, Green and Co., 39 Paternoster Row, E.C.4. Price 6s.

*The Microscope.* How to choose it and use it. By S. E. Dowdy, M.P.S., F.R.M.S. 1921. 53 pp. and 1 pl. Published by A. E. Soman and Co., Norwich. Price 5s. 6d.

- The Beginner's Guide to the Microscope.** By Charles E. Heath, F.R.M.S. 1922. 120 pp. Published by Percival Marshall and Co., 66 Farringdon Street, E.C.4. Price 1s. 6d.
- Brown Bast.** An Investigation into its Causes and Methods of Treatment. By A. R. Sanderson, F.L.S., and H. Sutcliffe, A.R.C.Sc., F.R.M.S. 1921. 71 pp. and 26 pls. Published by The Rubber Growers' Association, 2 Idol Lane, E.C.3.
- Considérations sur l'Être Vivant.** By Charles Janet. 1920 and 1921. Part 1, 80 pp. and 1 pl. Part 2, 196 pp. and 1 pl. Published by Imprimerie Dumontier et Hagué, 23 Rue Jules-Michelet, Beauvais.
- Journal of Scientific Instruments.** A monthly publication dealing with their principles, construction and use. Preliminary Number, May, 1922. Published by the Institute of Physics, 10 Essex Street, W.C.2.
- Revue d'optique Théorique et Instrumentale.** First Number of a monthly journal, January, 1922. Published by Librairie Chapelot, 136 Boulevard Saint-Germain, Paris. Price fr. 2.50.
- The Geological Work of Charles Lapworth.** By W. W. Watts. 1921. 51 pp. Special Supplement to Vol. XIV. of the Proceedings of the Birmingham Natural History and Philosophical Society. Price 2s.
- Foraminifera of the Philippine and Adjacent Seas.** By Joseph A. Cushman. 1921. 608 pp. and 100 plates. Published by the Smithsonian Institute, Washington, U.S.A.
- A Monograph of the Existing Crinoids.** Vol. I., The Comatulids, Part 2. 1921. xxvi + 795 pp., 57 plates. Published by the Smithsonian Institute, Washington, U.S.A.
- Modern Microscopy.** A Handbook for Beginners and Students. By M. I. Cross and Martin J. Cole. Fifth edition revised and rearranged by Herbert F. Angus, F.R.M.S. 1922. x + 315 pp., 12 plates, 144 text-figures. Published by Ballière, Tindall and Cox, 8 Henrietta Street, W.C.2. Price 10s. 6d. net.
- The Free-living Unarmoured Dinoflagellata.** By Charles Atwood Kofoid and Olive Swezy. 1921. 562 pp., 12 coloured plates, 388 text-figures. Published by the University of California, Berkeley, California. Price 12.50 dollars.
- The Marine Decapod Crustacea of California.** By Waldo L. Schmitt. 1921. 470 pp., 50 plates, 165 figures in text. Published by the University of California Press, Berkeley, California. Price 5 dollars.
- Contributions toward a Monograph of the Sucking Lice.** Part II. By Gordon Floyd Ferris. 1921. 81 pp., 57 text-figures. Published by the Stanford University, California. Price 1 dollar.

# PROCEEDINGS OF THE SOCIETY.

## AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, W., ON  
WEDNESDAY, MARCH 15TH, 1922, PROFESSOR F. J. CHESHIRE,  
PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed by the President.

The nomination papers were read of seven Candidates for Fellowship.

**New Fellows.**—The following were elected Ordinary Fellows :—

Mr. Archie Adcock.  
Mr. Frank E. Challis.  
Mr. Edward E. Ellis.  
Dr. R. Ruggles Gates, M.A., F.L.S.  
Mr. Leonard G. Hulls, F.C.S.  
Mr. P. H. Johnson, B.A., B.Sc., etc.  
Mr. Edward K. Maxwell, B.A.  
Mr. Joseph S. Preston.  
Mr. Harry B. Price.

The Death was reported of Professor Benjamin Moore, who was elected a Fellow of the Society in 1916.

Mr. W. E. Watson Baker gave a description of the small Swift Pocket Microscope recently presented to the Society by Mr. Ernest Keevil. He said that Mr. Powell Swift had given him the following information regarding its history :—

“The instrument in question was made specially for the late Sir Frank Crisp in 1878 or 1879, and was actually made by Mr. Swift, Senior. Mr. Crisp, as he was then, was delighted with the ingenuity and good workmanship displayed, and on his suggestion the late John Mayall, Junior, wrote a description of the outfit which was published in the ‘English Mechanic.’ The conical upright of the small stand

unscrews and leaves a sharp steel point by means of which the instrument could be affixed to a fence or tree for use in the field. Another point worth noticing is the correction adjustment of the objectives. It was listed in the 1878 Catalogue. The G. T. Brown, to whom is given the credit of the design, eventually became Sir George Brown, P.C. A number of these little stands were made, probably about three dozen."

The workmanship of this instrument is worth examination, and it constitutes one of the most interesting portable instruments of its type.

In the description of the instrument care is taken to point out that the objectives have been specially corrected for the short tube length; coarse adjustment is obtained by sliding the objective carrying tube in its fitting, and the fine adjustment is obtained by moving the eyepiece tube, which enables the object to be accurately focused.

The price of this outfit when purchased was as follows:—

	£	s.	d.
Microscope in case with "E" eyepiece, 1-in. and best			
$\frac{1}{8}$ -in. objective with adjustment for correcting for			
cover-glass thickness. . . . .	6	10	0
$\frac{1}{8}$ -in. objective with correction collar. . . . .	5	0	0
$\frac{1}{1\frac{1}{2}}$ -in. immersion objective with correction collar . . . . .	5	0	0
1 extra "C" eyepiece . . . . .	0	8	0
1 extra "D" eyepiece . . . . .	0	9	0
Polarizing apparatus . . . . .	1	15	0
Achromatic condenser with diaphragm for oblique			
light and dark ground . . . . .	2	0	0
Making a total of	£21	2	0

The thanks of the meeting were accorded to Mr. Watson Baker.

Dr. Drew and Dr. Murray exhibited three preparations to show the improved results obtained in Heidenhain iron-alum hæmatoxylin preparations, when purified hæmatoxylin is used for the staining solution. The method of purification will be published in the "Proceedings."

They were thanked from the Chair for the exhibit.

Dr. Murray read the following papers by Dr. H. Hartridge, M.A., M.D., F.R.M.S.: "Monochromatic Illumination," "A Low-Power Eye-piece with Large Field."

Mr. Joseph E. Barnard, F.Inst.P., F.R.M.S., read a paper entitled, "The Future of the Microscope in Medical Research."

Hearty votes of thanks were accorded to the authors of the above papers and to Dr. Murray.

The business proceedings then terminated.

## AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, W., ON  
WEDNESDAY, APRIL 19TH, 1922, PROFESSOR F. J. CHESHIRE  
PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed by the President.

The nomination papers were read of four Candidates for Fellowship.

**New Fellows.**—The following were elected Ordinary Fellows of the Society :—

Miss Rose Ellen Salt Cox.

Mr. John R. Elton-Bott.

Rev. George Stewart Hitchcock, D.B., F.R.A.S., F.C.S., F.R.G.S.

Mr. George Thomas Hollis.

Mr. Frederick Charles Lowe.

Mr. Robert M. Neill.

Mr. William Williamson, F.R.S.E., F.L.S.

The Treasurer read the Financial Report and presented the Balance Sheet for the year 1921, and moved that the same be adopted.

Mr. A. W. Sheppard seconded. Carried.

## FINANCIAL REPORT FOR THE YEAR 1921.

The Revenue Account shows an excess of Income over Expenditure of £8 8s. 8d. A valuation of the Society's securities shows an appreciation of £136, and they have been written up by this amount.

During the year one life membership fee has been received, and this has been placed to the credit of the Life Membership Account, which now stands at £204 15s.

Compared with last year the income of the Society shows a net increase of £204, while the expenditure has decreased by £91.

Dr.

## INCOME AND EXPENDITURE ACCOUNT

Dec. 31, 1920.			£ s. d.	£ s. d.	£ s. d.
£ s. d.					
164 18 6	To Rent and Insurance . . .				164 13 6
292 16 11	„ Salaries and Reporting . . .				344 9 1
	„ Sundry Expenses—				
	Library, Books and Binding		25 15 1		
	Stationery, Printing, etc. . .		89 8 1		
	Petty Expenses and Postage		46 14 11		
228 5 0	„ Journal—				161 18 1
	Expenditure—				
	Printing . . . . .	741 6 0			
	Editing and Abstracting . .	79 11 6			
	Illustrating . . . . .	54 0 4			
	Postages, etc. . . . .	24 19 6			
			899 17 4		
	Less Receipts—				
	Sales . . . . .	358 6 5			
	Advertisements . . . . .	123 19 10			
			482 6 3		
499 11 6	„ Expenses of Conversazione . .				417 11 1
74 1 3	„ Donation to Marine Biological				32 7 3
5 5 0	Association . . . . .				52 10 0
- - -	„ Balance, being excess of Income				8 8 8
	over Expenditure				
1264 18 2					£1181 17 8

Dr.

## BALANCE

Dec. 31, 1920.			£ s. d.	£ s. d.	£ s. d.
£ s. d.					
	LIABILITIES.				
	To Sundry Creditors—				
	Subscriptions paid in Advance		22 11 6		
	On A/c Journal Printing, etc.		420 8 5		
421 3 0	Marine Biological Association		52 10 0		495 9 11
	„ Life Membership Account . .		181 2 6		
181 2 6	Add Fees received in 1921 . .		23 12 6		204 15 0
	„ Capital Funds—				
1565 3 11	Balance as per last A/c . . .	1565 3 11			
	Add Increase of value of				
	Society's Investments . . .	136 0 0			
	Add Excess of Income over				
	Expenditure for year . . . .	8 8 8			
					1709 12 7
2167 9 5					£2409 17 6

(Signed) C. F. HILL, *Hon. Treasurer.*  
5th April, 1922.

## Cr.

SHEET.

Cr.

We have examined the accounts as above set forth, and have verified the same with the books, vouchers and securities belonging to the Society, and, in our opinion, the Balance Sheet is properly drawn up so as to exhibit a true and correct view of the Society's affairs, but no account has been taken of the value of the Society's Library, Instruments and Stocks of Journals (valued for Insurance at £3500).

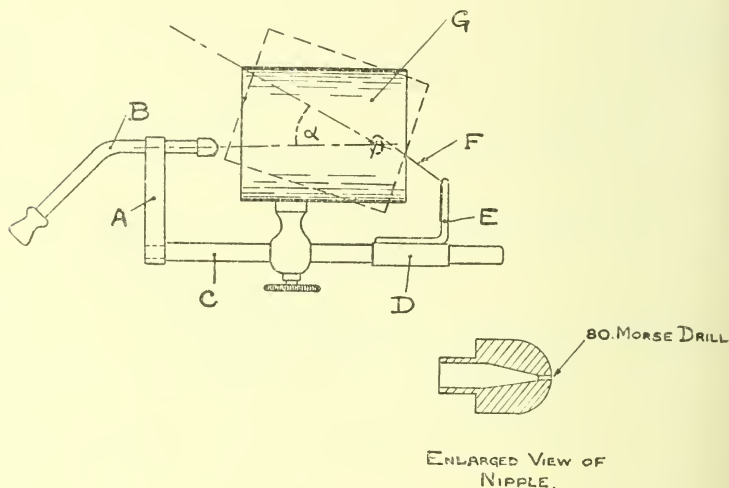
(Signed) T. H. HISCOTT,  
H. H. MORTIMER, } *Hon. Auditors.*

The result of the appeal for special subscriptions from Fellows was that the income from subscriptions was increased by £100 18s. 2d., and on the expenditure side of the account a special donation of 50 guineas was made to the Marine Biological Association.

It will therefore be noted that without the special appeal the account would have shown an excess of *Expenditure* over Income of £40.

The income from Admission Fees is the highest recorded in the history of the Society. The Council wish to impress upon Fellows the continued necessity of getting as many new Fellows as possible, in order that the improvement shown may be maintained in the current year.

**The President** (Professor Cheshire) exhibited a simple thorium-disc lamp designed by himself. The figure shows the lamp half-size. In parallel holes in a short piece A, of square section brass rod, a brass tube B and a steel rod C are soldered. The brass tube is fitted with a nipple—bored with an 80 Morse drill—at one end and with an enlargement for engaging a rubber tube at the other. A tube D, carrying an upright wire E, slides on the rod C and bears a platinum wire F, to the



end of which the thorium disc is secured. A shade, if required, is provided in the form of a short tube G, which slides on the rod C, to which it is clamped by a screw. When the axis of the tube G is parallel to and vertically above the axis of the jet, the available emission angle is  $\alpha$ , and this is usually sufficient. It can, however, be increased by tilting the tube on its clamp, as shown in dotted lines. The lamp can be very simply fitted to a stand such as that of a bull's-eye condenser.

The advantages of this design of lamp are, amongst others, a very simple construction, and a simple sliding adjustment for the disc along the axis of the gas jet. The adjustments of the disc are thus made independent of one another.

On the motion of **Mr. Hill** the President was thanked by the meeting for his exhibit.

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The following papers were read :—

**Mr. Herbert Sutcliffe, A.R.C.Sc., F.L.S., F.R.M.S.** (Rubber Growers' Association)—

“The Use of the Microscope in the Rubber Industry.”

In the absence of **Mr. Sutcliffe**, this paper was read by **Sir Stanley Bois**.

**Mr. Conrad Beck, C.B.E., F.R.M.S.**—

“The Photometry of a Bull's-Eye Lens for Illuminating Microscopic Objects.”

**Dr. S. C. Harland, D.Sc., and Mr. J. H. Denham, M.A., F.R.M.S.** (The British Cotton Industry Research Association).

“The Use of the Microscope in Cotton Research.”

**Dr. R. J. Ludford, Ph.D., B.Sc., F.R.H.S., F.R.M.S.**—

“The Morphology and Physiology of the Nucleolus.”

**Mr. W. Rushton, A.R.C.Sc., D.I.C., B.Sc.**—

“A New Trematode from Rainbow Trout.”

Hearty votes of thanks were accorded to the authors of the above papers, and to **Sir Stanley Bois** ; also to **Messrs. W. Watson & Sons, Ltd.**, for the loan of microscopes.

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The business proceedings then terminated.

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## AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, W., ON  
WEDNESDAY, MAY 17TH, 1922, PROFESSOR F. J. CHESHIRE,  
PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed by the President.

The nomination papers were read of three Candidates for Fellowship.

**New Fellows.**—The following were elected Ordinary Fellows of the Society :—

Mr. Arthur Benjamin Bradley, F.C.S.

Mr. James Joseph Jackson.

Mr. Arthur Mackay.

Mr. J. R. Norman.

**Donations** were reported as follows :—

Mr. S. E. Dowdy—"The Microscope."

M. Charles Janet—"Considérations sur l'Être Vivant."

Messrs. Longmans, Green & Co.—

"Practical Plant Biology." (H. H. Dixon.)

Messrs. Percival Marshall & Co.—

"The Beginner's Guide to the Microscope." (C. E. Heath.)

Thanks were accorded to the donors.

**Pond-Life Exhibition.**—The President then called upon Mr. Scourfield to make some observations on the Annual Exhibition of Microscopic Pond-Life which had been arranged by Fellows of the Society and Members of the Quekett Microscopical Club.

Mr. Scourfield said that in his introductory remarks in connexion with the Pond-Life Exhibitions he had emphasized the importance from a number of different points of view of the study of living fresh-water organisms. This was not so much because being a Pond-Life enthusiast himself he thought that there was "nothing like leather," but rather that the living material most easily obtainable by the majority of microscopists was obviously the minute life of our lakes, ponds, and ditches. Personally he would be very glad to see regular exhibitions of other living microscopic organisms, and especially of living marine organisms, but he was afraid that the difficulties in the way of obtaining

the necessary material in London rendered such exhibitions impracticable. That evening he proposed to refer to the question of the adhesion and attachment of many fresh-water organisms to various animate and inanimate objects in the water. At first sight it might appear a very simple matter that a minute plant or animal should attach itself to some other body, but when it was remembered that nearly all groups of aquatic organisms were originally almost certainly either free-floating or free-swimming, it was evident that many special modifications had been required corresponding with the very varied modes of attachment which were represented. Considering the subject from the point of view of the degree of adhesion or attachment it could be stated generally that the numerous cases of permanent attachment were due to some exuded material which had the property of hardening under water. There were probably many different kinds of such substances produced, and if their exact nature could be determined by some application of micro-chemical analysis, the results might be of far-reaching importance. The cases of semi-permanent attachment, such as *Hydra* for example, were due usually to the production of glutinous secretions which did not harden under water, but remained in a "tacky" condition. The most varied and interesting kinds of attachment were, however, those of a temporary nature. The simplest types were probably those due to the slightly sticky nature of protoplasm itself, and many examples of this could be given among the Rhizopoda, Flagellata, &c. A striking illustration was the use of a flagellum, as in *Bodo*, for adhering to and gliding upon the glass slide or cover-slip, and no doubt also upon water plants, &c. Another type of temporary attachment was brought about by a secretion from special glands, such as occurred in the toes of Rotifers and on the back of the head in *Sida crystallina*. True suckers were used for attachment in some cases, e.g. *Argulus*, and many leeches, while hook-shaped hairs and setæ were naturally the means employed in numerous other cases, especially among the Entomostraca, e.g. *Simocephalus*, *Cyclops*, &c. But perhaps the most peculiar of all methods of temporary attachment was that in which the organisms, although heavier than water, made use of the surface-film of water for support. This was rendered possible by the water-repellent nature of various specialized portions of the body, setæ, scales, &c., which produced capillary depressions when brought into contact with the surface-film, and thus enabled the organisms to take advantage of the upward pull due to surface tension. Examples of this method of attachment were *Hydra*, *Scapholeberis*, *Notodromas*, &c.

Mr. Scourfield then referred in detail to the various objects exhibited. He commented on the fact that, unlike any previous Pond-Life Exhibition he could remember, not a single example of the Polyzoa was being shown. On the other hand, two of the worm types—*Chætogaster* and *Mesostomum* were being exhibited which had not been the case for at least some years past.

On the motion of the President, a hearty vote of thanks was accorded to the Members of the Quekett Microscopical Club, and to the Fellows of the Royal Microscopical Society who had kindly exhibited specimens, and to Mr. Scourfield for his remarks.

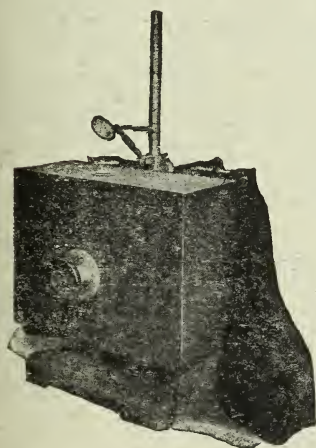
The following **Objects** were exhibited :—

Mr. Atwell . . . .	<i>Vorticella</i> sp.
Mr. W. E. Watson Baker	<i>Rotifera</i> — various free-swimming forms.
Mr. C. H. Bestow . .	<i>Volvox globator</i> .
Mr. A. J. Bowtell . .	<i>Cyclops agilis</i> .
Mr. J. Burton . . . .	Filamentous iron-bacteria.
Mr. C. Campbell . . .	<i>Euplotes patella</i> .
Mr. F. W. Chippis . .	<i>Vallisneria spiralis</i> , showing cyclosis.
Mr. F. E. Cocks . . .	<i>Brachionus sericus</i> .
Mr. R. F. G. Cole . .	<i>Hydatina senta</i> , <i>Anuræa cochlearis</i> , etc.
Mr. A. J. Curwen . . .	Diatoms, various— <i>Pleurosigma</i> , etc.
Mr. B. S. Curwen . . .	<i>Daphnia longispina</i> .
Mr. E. Cuzner . . . .	<i>Stentor polymorphus</i> (green).
Mr. D. Davies . . . .	<i>Hydra viridis</i> .
Mr. M. T. Denne . . .	<i>Floscularia ornata</i> .
Mr. H. Goullee . . . .	Eggs of Water-mite on <i>Nitella</i> .
Mr. H. J. Lawrence . .	<i>Eosphora aurita</i> .
Dr. R. Ludford . . . .	<i>Scenedesmus acutus</i> and <i>Ankistrodesmus falcatus</i> .
Mr. R. H. Marchment .	Early stages of common toad.
Mr. E. R. Martin . . .	<i>Hydra vulgaris</i> .
Mr. E. Maurice . . . .	<i>Hydra viridis</i> .
Mr. H. H. Mortimer . .	<i>Coriza</i> sp. (young).
Dr. J. A. Murray . . .	<i>Chætogaster</i> sp.
Mr. J. C. Myles . . . .	<i>Simocephalus vetulus</i> .
Mr. E. R. Newmarch . .	<i>Melicerta ringens</i> and <i>Volvox globator</i> .
Mr. J. M. Offord . . .	<i>Melicerta ringens</i> , with rings of red pellets, the result of the animals being supplied with carmine for four days.
Mr. J. Pledge . . . . .	<i>Daphnia pulex</i> , shown with Rheinberg colour disc.
Mr. J. Pollard . . . .	<i>Daphnia pulex</i> .
Mr. H. N. R. Room . . .	<i>Trachelomonas hispida</i> .
Mr. W. Russell . . . .	<i>Closterium</i> sp., showing cyclosis.
Mr. D. J. Scourfield . .	<i>Mesostomum</i> sp., showing ciliated body, eyes, eggs, etc.
Mr. R. S. W. Sears . . .	<i>Chromatium okeni</i> .
Mr. C. J. H. Sidwell . .	<i>Mesostomum</i> sp., showing pharynx, etc.
Mr. E. J. Summers . . .	<i>Simocephalus serrulatus</i> .
Mr. B. J. Thomas . . . .	Larva of dragon-fly.
Dr. C. Tierney . . . .	<i>Amæba proteus</i> , with dark-ground illumination, showing active streaming of endosarc.
Mr. L. H. Tinson . . . .	<i>Vorticella</i> sp.
Mr. C. Todd . . . . .	<i>Hydra viridis</i> .
Mr. H. C. Whitfield . .	<i>Epistylis</i> sp. and <i>Vorticella</i> sp.
Mr. J. Wilson . . . . .	<i>Carteria multifilis</i> and <i>Closterium moniliferum</i> .

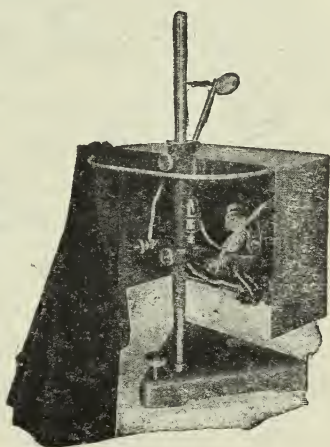
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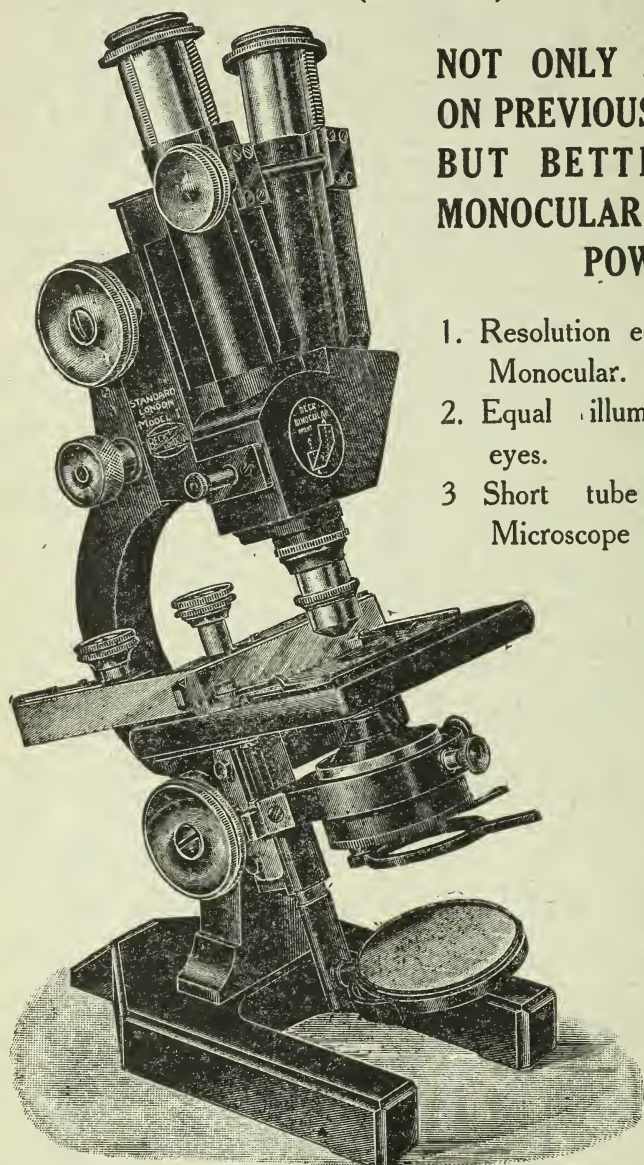
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# Journal of the Royal Microscopical Society

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS

AND

A SUMMARY OF CURRENT RESEARCHES

RELATING TO

**ZOOLOGY AND BOTANY  
MICROSCOPY, &c.**

EDITED BY

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AND

**CHARLES SINGER, M.A. D.Litt. F.R.C.P.**

*Lecturer in the History of Medicine in the University of London*

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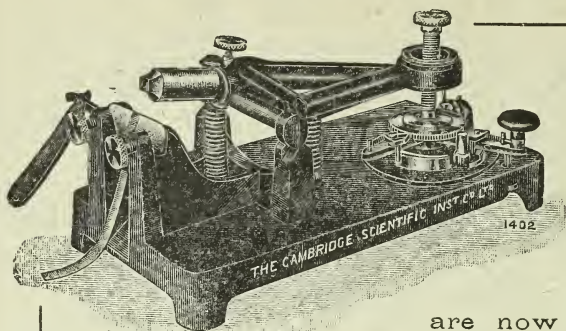
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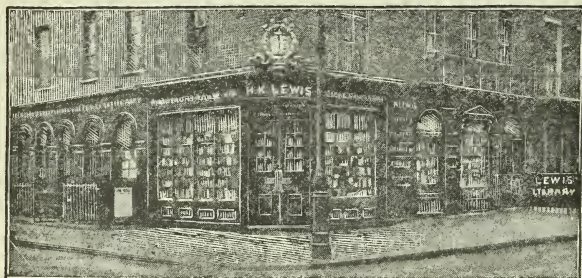
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## SPECIAL NOTICES.

SESSION 1922-23.—For Programme of Papers, etc., see following pages.

A CONVERSAZIONE will be held on WEDNESDAY, OCTOBER 11, 1922, from 7.30 to 10.30 p.m., at the EXAMINATION HALL, 8-11 Queen Square, Bloomsbury, London, W.C.1. (Nearest Stations: Holborn and Russell Square.)

RECEPTION BY THE PRESIDENT, PROFESSOR FREDERIC J. CHESHIRE, C.B.E., F.Inst.P., from 7.45 to 8.15 p.m.

The Council of the Society is most desirous of securing the co-operation of Fellows and others who can contribute to the success of the Conversazione, and those who are willing to provide Exhibits of any kind having relation to the Microscope and microscopic organisms and structures are asked to notify the Secretary as early as possible.

THE TRADE DIRECTORY AND INDEX TO ADVERTISERS will be found on page 15.

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## Preliminary Announcement

# PROGRAMME for the SESSION 1922-1923

October 18 ... PROFESSOR ROBERT CHAMBERS.

*Communicated by Professor R. Ruggles Gates,  
M.A., Ph.D., F.R.M.S.*

“New Apparatus and Methods for the Dissection and  
Injection of Living Cells.”

MR. THOMAS F. CONNOLLY, M.B.E., M.Sc., F.Op.S.,  
F.R.M.S.

(Inspector of Scientific Supplies, India Office)

“The Specification of a Medical Microscope.”

MR. HUMPHRY J. DENHAM, M.A.(Oxon.), F.R.M.S.

“A Micrometric Slide Rule.”

November 15 MR. CONRAD BECK, O.B.E., F.R.M.S.

“Glare and Flooding in Microscope Illumination.”

DR. CHARLES SINGER, M.A., F.R.C.P., F.R.M.S.

“The First Mechanical Microtome.”

PROFESSOR GOBIND SINGH THAPAR, M.Sc., F.R.M.S.

“The Occurrence and Significance of a Third  
Contractile Vacuole in *Paramecium caudatum*.”

PROFESSOR B. L. BHATIA, M.Sc., F.Z.S., F.R.M.S.

“On the Significance of Extra Contractile Vacuoles  
in *Paramecium caudatum*.”

December 20 MR. JOSEPH E. BARNARD, F.Inst.P., F.R.M.S.

“Sub-Bacteria.”

1923.

January 17 ANNUAL MEETING.

## PRESIDENTIAL ADDRESS.

PROFESSOR FREDERIC J. CHESHIRE, C.B.E., F.Inst.P.,  
P.R.M.S.

“The Petrological Microscope and its Optical Evolu-  
tion.”

February 21... PROFESSOR SIR WILLIAM MADDOCK BAYLISS, D.Sc.,  
F.R.S., F.R.M.S.

“Microscopical Staining and Colloids.”

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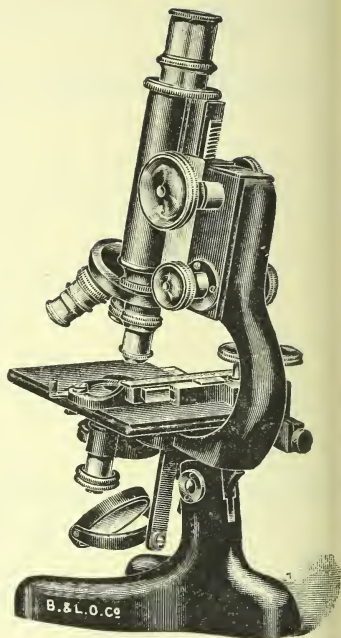
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"Test Plates for Microscopes, and Microscopic Definition."

MR. J. R. NORMAN, F.R.M.S.

"Methods and Technique of Reconstruction."

March 21 ... MR. EMIL HATSCHEK, F.Inst.P.

"The Standard Methods of Ultra-Microscopy."

DR. A. C. THAYSEN. (Royal Naval Cordite Factory)

"The Destruction of Cotton and other Fabrics by Bacteria, and the Importance of the Microscope in the Study of this Destruction."

April 18 ... DR. WILLIAM B. BRIERLEY, F.L.S., F.R.A.I.

(Mycological Department,  
Rothamsted Experimental Station)

"The Microscope in Agricultural Research."

PROFESSOR A. C. SEWARD, M.A., F.R.S., F.G.S.

(Master of Downing College, Cambridge)

"The Use of the Microscope in Palæobotanical Research."

May 16 ... MR. LEONARD TAVERNER, A.R.S.M.

"The Principles and Application of Technical Metallurgical Microscopy."

MR. W. M. AMES, M.A., B.Sc., A.I.C.

"Applications of the Microscope in the Manufacture of Rubber."

May 23 ... **ANNUAL POND LIFE EXHIBITION.**

(Extra Meeting)

June 20 ... DR. JAMES A. MURRAY, F.R.M.S.

Will communicate Papers by the late Dr. J. E. Blomfield.

(a) "Witches' Brooms."

(b) "Tumours of Trees: Birch."

**SPECIAL NOTE.**—The issue of this Provisional Programme must not be regarded as final. It is hoped that further original communications will be received, and opportunity will be found for the reading of such communications on any evening other than January 17th.

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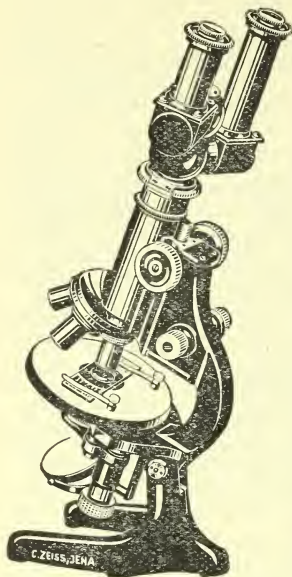
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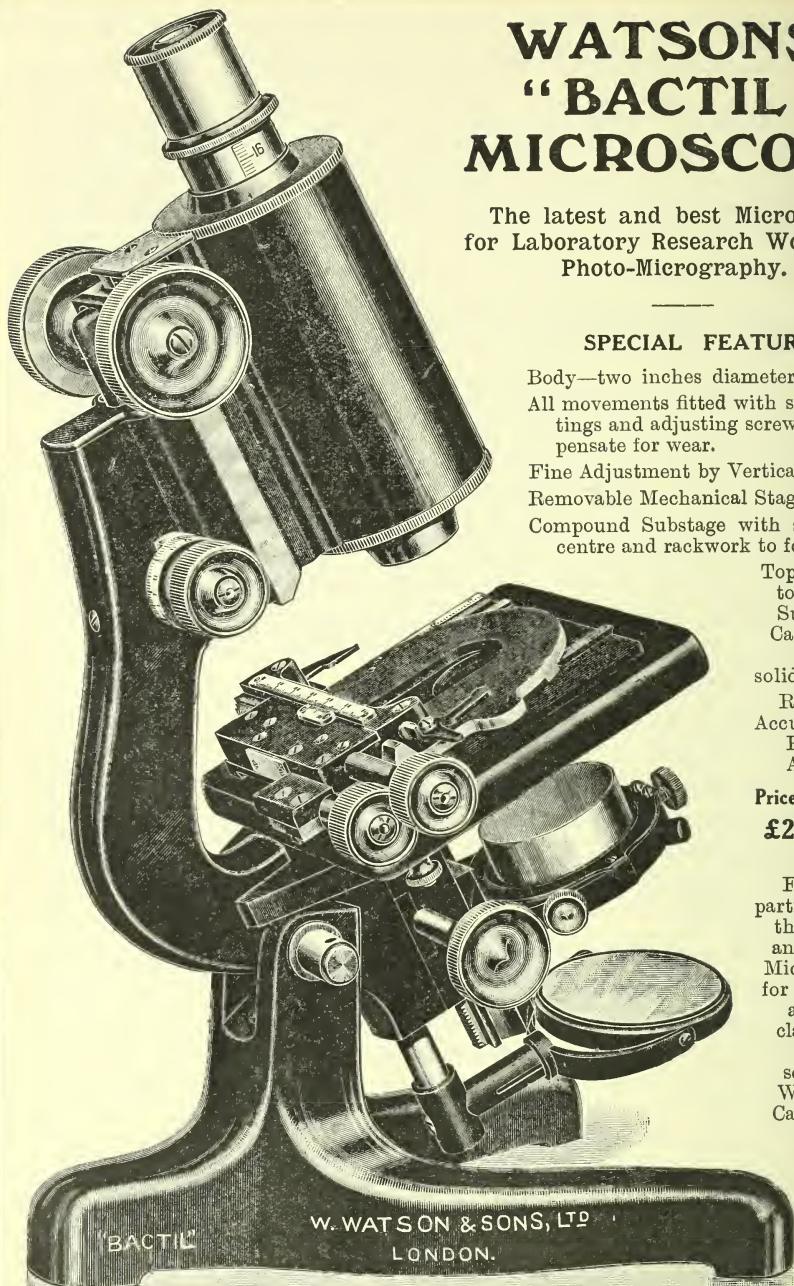
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VIII.—THE GAMETOGENESIS OF NEPA CINEREA  
(WATER SCORPION).

By E. A. SPAUL, B.Sc., F.Z.S., Department of Zoology,  
Birkbeck College, University of London.

(Read June 21, 1922.)

TWO PLATES.

A LARGE amount of work has been done on the group *Hemiptera* (Wilson, Montgomery, Stevens and others), mainly on account of the ease with which its members can be obtained, and the suitability of the material when prepared for favourable study of cytological phenomena; but so far, except for a brief reference, no observations have been made on the family Nepidae (Water Scorpions) belonging to the aquatic *Rhynchotha*. It includes two common forms, *Nepa* and *Ranatra*, although the latter is now becoming rare and confined to the South of England. The work done so far consists of a few observations of Chickering on the spermatogonia of *Ranatra*, but although literature is scarce so far as this family is concerned, several papers on the closely related family Notonectidae have been published by Browne, who has made detailed investigations.

The water scorpions are rather sluggish in their movements, feeding on small insects and aquatic animals, and creeping leisurely about the bottom of ponds during spring and summer. The whole history of the germ cells of *Nepa cinerea* is found in the sex organs from spring up to midsummer, so that specimens captured in spring contain only spermatogonial divisions and early meiotic prophase, but those captured in the middle of the summer give spermatocyte divisions in addition.

In the female there are two ovaries consisting of a number of ovarioles of the typical Hemipteran type, with the single large nutritive chamber at the apex connected by ducts with the

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growing oocytes, so that nourishment flows from the nurse cells to the egg. The paired testes are follicular, lying on either side of the alimentary canal.

The material used consisted of several ovaries and testes from nymphs collected in spring and others in midsummer. They were dissected in saline solution, the earlier collection fixed in Flemming's and the latter in Bouin's fluid, and the preparations stained with iron-haematoxylin (Haidenhain's).

As the preparations were made from specimens collected in spring and summer, an examination of the sections of the testes revealed all the stages in the nuclear cycle, from the spermatogonia to the last spermatocyte division and the formation of the spermatids. The cells developed together in groups of from eight to sixteen, each number passing through the same stage as other members of the group.

The spermatogonial nuclei were characterized by a pronounced darkly staining nucleolus in the centre of a clear space, with smaller irregular masses of chromatin distributed throughout the remainder of the lightly staining area of the nucleus. These irregular masses broke into smaller granules in preparation for division of the primary spermatocyte; at the same time the nucleus increased in size. The metaphase of the spermatogonial division gave several examples of the equatorial plate with the chromosomes well separated and clearly defined, making a large number of counts possible and giving consistent results. The diploid complex for the male was thirty-five, the chromosomes being of various sizes, but variation was not great, and beyond two pairs of small ones there were no conspicuous members. In all cases they were stout rod-like, with rounded ends, the larger slightly curved, but the smaller practically spherical. Chickering found two types of testes as regards the chromosome number in *Ranatra*, the first type having forty of various sizes, and the second type eight or ten more, but careful search among my preparations failed to reveal any such peculiar polymorphism of the spermatocyte. It is impossible to comment without further details, but unless different species were dealt with, fragmentation of the chromosomes may have taken place, particularly as a farther note mentions a group of small chromosomes near the centre of a larger group,

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#### EXPLANATION OF PLATE X.

- Fig. 1.—Equatorial plate of spermatogonia. Diploid complex 35.  
 Fig. 2.—Equatorial plate of oogonia. Diploid complex 36.  
 Fig. 3.—Primary spermatocyte.  
 Fig. 4.—Maturation stages of male. Leptotene.  
 Fig. 5.—Maturation stages of male. Zygotene.  
 Fig. 6.—Maturation stages of male. Bouquet stage.  
 Fig. 7.—Maturation stages of male. Contraction figure.  
 Fig. 8.—Maturation stages of male. Diplotene.

and examination of the complete cycle of nuclear changes might explain the matter. The primary spermatocytes having increased in size undergo the characteristic nuclear changes in preparation for reduction division. There is a large darkly staining prominent body, the nucleolus, present, whilst the chromatin is distributed through the nuclear space in a tangled mass of lightly staining threads derived apparently from the irregular masses of chromatin, already mentioned, but as the number of these masses varies in different nuclei, and as it was impossible to follow the formation of the threads from them, it cannot be maintained definitely that the latter represent chromosomes in the resting stage as has been suggested (Wilson). The threads become finer and more distinct with still no definite arrangement until the loose ends of the threads appear concentrated on one pole. They are very numerous and counting with any certainty is out of question. Thickening occurs, and the threads stain more deeply, whilst the number is reduced, due to pairing, although the actual process of fusion is difficult to follow. Meantime the tangled network straightens out, the threads shorten, and definite loops appear to form the "bouquet" stage. Contraction to the pole at which the threads first appeared follows, leaving the remainder of the nucleus clear. In the diplotene stage the thickened reduced filaments appear from the light mass of the contraction phase, displaying in some cases longitudinal cleavage with a tendency to form some sort of a ring, others only partially so, forming a ring at one end, and others just showing a slit. Here the nucleolus, which up to this stage had remained unchanged, appears to be attached to some of these threads. It is much reduced in size and irregular in outline. This stage of partially formed rings and attachments of the threads to the nucleolus has been noted in *Notonecta*. Eventually the haploid number of longitudinally split threads contract and become detached, whilst the nucleolus is unrecognizable. Transformation to tetrads follows, but I failed to find a satisfactory section of this stage; in fact difficulty was experienced in clearing up these later stages. The chromosomes arrange themselves regularly along the spindle which has now been formed. Close examination of several of these spindles showed the presence of an unpaired chromosome, and in the anaphase stage a chromosome is seen either in front of or behind the others, but usually the latter. This is evidently the hetero-chromosome, which it has been hitherto impossible to identify, for it is about the same size as the larger chromosomes of the diploid complex. After a careful examination of my preparations I have come to the conclusion that the hetero-chromosome passes to the pole of the nucleus in the first spermatocyte division and divides equationally in the second, and further that it may precede or follow the autosomes when they converge to the poles after division; and as regards its origin its behaviour has not

been such as to enable me to identify it before this stage, although it may possibly be derived from the nucleolus after its reduction in size. In *Ranatra* Chickering finds in the first type twenty-one chromosomes, all of which divide equally in the primary division, whilst in the secondary there are twenty-one again, but two do not divide, passing into different spermatids, so that each possesses twenty chromosomes. These are described as the typical XY-group, but owing to their behaviour, their identification is not possible before this stage. In the second type no numbers are given nor X and Y chromosomes described, the only note being a reference to a group of small chromosomes near the centre of a larger group, which seems to be a distinguishing feature, but nothing corresponding to this has been found in *Nepa*. An examination of the equatorial plates of the primary division gives further evidence in favour of the fact that the X-chromosome passes over in the first division. It was found that approximately half the counts gave seventeen and the other half eighteen in the same group of cells. The chromosomes varied in size, there being nothing conspicuous, and on close examination and comparison they were found to practically correspond in size except for one of the larger members. In *Notonecta* there is an XY-group which apparently divides equationally in the first division, but they separate in the second.

The preparations of the oögonia covered all the stages up to the growth stage of the egg. Oögonial mitoses were not so frequent as those in the spermatogonia, but sufficient numbers were studied to enable satisfactory counts to be made. They resulted in thirty-six being the diploid complex, so that the unpaired element of the male germ cells is accompanied by a homologous partner. Here again the chromosomes varied, but there were no outstanding members. The nuclear figures accompanying the maturation stages were essentially identical with those phenomena of the spermatocytes as far as the diplotene, the nucleolus being as before very prominent. At this stage differentiation into follicle and nurse cells and oocytes took place. In the latter case the threads remain, but gradually disappear as the nucleolus increases in size and the cell moves towards the neck of the nutritive chamber.

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#### EXPLANATION OF PLATE XI.

*Fig. 8a.*—Maturation stages of male. Diplotene showing ring formations.

*Fig. 9.*—Spindle of first division showing unpaired chromosome.

*Fig. 10.*—Equatorial plate of second spermatocyte, 17 chromosomes.

*Fig. 11.*—Equatorial plate of second spermatocyte, 18 chromosomes.

*Fig. 12.*—Anaphase stage of division showing X in front of autosomes.

*Fig. 13.*—Anaphase stage of division showing X behind autosomes.

*Fig. 14.*—Ejection of particles from nucleus showing others in cytoplasm.

*Fig. 15.*—Resting stage of egg showing yolk particles at border of egg follicle cells, and diffuse stage of nucleus.

The nucleolus remains, becoming very large and staining deeply, whilst the disappearing threads stain more lightly, passing finally into the reticulate stage characteristic of the growth phase of the egg. Rapid growth takes place and yolk accumulates in the cytoplasm. In the case of the nurse and follicle cells the diplotene threads contract and break up in irregular masses of chromatin, and distribute themselves about the nucleus, which does not increase in size. The nucleolus remains staining deeply, and the cells develop either into nurse cells, remaining in the nutritive chamber, or surround the oocyte as it passes down the tube, becoming follicle cells. Meantime the oocyte increases considerably in size owing to the deposition of yolk. Darkly staining particles appear in the yolk at this stage, and in a few preparations the emission of particles from the nucleolus and nucleus itself was noticed. The appearance of these particles in the cytoplasm marks the enormous increase in the size of the egg owing to yolk formation. As the egg grows they break up into smaller ones and migrate to the edge of the egg, so that in the ripe egg these particles are collected round the border of the egg. By this time the nucleolus has considerably increased in size and does not stain uniformly, having lighter areas, giving it a vacuolar appearance. This is due possibly to internal changes. After the first extrusion noticed in the early stages nothing further happens, and hence it seems that the particles are thrown out by the nucleolus to stimulate the deposition of yolk. This interpretation has been applied to other types, and there seems no reason why such is not the case here. In fact the formation of yolk in the egg indicates a functional relationship between the nucleolus and the production of yolk, a conclusion many have reached after studying oogenesis in insects. A similar observation has been made by Browne in *Notonecta* as regards the behaviour of the nucleolus. It is described as the "Karyosphere," consisting of chromatic bodies embedded in plasmosome material, from observations on the vesicular appearance during the growth period of the egg and formation of yolk and the increase in size of the primary spermatocyte, and further is supposed to supply the chromosomes with chromatin. However, the latter is questionable, for although in the male it appears attached in some cases, but not all, to the diplotene threads and is eventually unrecognizable, it persists in the female becoming very large in the growth stages, so that there is insufficient evidence to trace the supply of chromatin of the chromosomes to the nucleolus.

#### SUMMARY.

1. Nuclear organization in the germ cells of *Nepa cinerea* has been investigated and compared with related types.

2. The diploid complex in male germ cells consists of thirty-five chromosomes of various sizes, that of the female thirty-six.

3. The maturation stages are typical, with definite polarization of threads.

4. There is a single X-chromosome in the male and a pair in the female, but they are not conspicuous, and unable to be identified until division takes place. This differs from *Notonecta* and *Ranatra*, which have an XY-group.

5. The X-chromosome converges to one pole either before or behind the autosomes in the first division, and divides equationally in the second. This is confirmed by haploid numbers seventeen and eighteen of the secondary spermatocytes. *Notonecta* and *Ranatra* separate in the second division.

6. The differentiation of the oocytes, nurse cells and follicle cells does not take place till after synapsis.

7. The ejection of particles from the egg nucleus in the growth stage coincides with the deposition of yolk.

8. The nucleolus is conspicuous throughout all the oocyte stages and up to the diplotene in the male. It consists of chromatic bodies embedded in plasmosome material, the amount of each varying with the stages.

9. There are marked differences between *Nepa cinerea* and *Ranatra* and also *Notonecta*, notably the diploid complex, the XY-group, the separation of X in the first instead of the second divisions, and as regards the former only there is no polymorphism of the spermatocytes.

10. There is similarity in the presence and behaviour of the nucleolus and the appearance of the diplotene threads in ring formations.

11. There is a difference with other members of the group *Hemiptera* in the orientation of the maturation figures, and the reduction of X-chromosome in first and not second division.

This investigation was carried out at Birkbeck College. I am greatly indebted to Dr. Hogben for the preparations he gave me to carry on the work, and further for helpful advice and suggestions throughout.

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## IX.—A LOW-POWER EYE-PIECE WITH LARGE FIELD.

By H. HARTRIDGE, M.D., Sc.D., F.R.M.S., Fellow of  
King's College, Cambridge.

(Read March 15, 1922.)

## ONE TEXT-FIGURE.

ONE of the disadvantages of the Huyghens type eye-piece is that the lower powers possess so small a field of view compared with those of the high powers. The eye-pieces of different magnifying power in a series should have the same size of field, whereas actually the size is found to decrease as the magnifying power decreases, as the following Table shows:—

		<i>Ordinary Eye-pieces.</i>					
Magnifying power .. ..		× 5	× 6	× 8	× 10	× 20	× 25
Size of field in cm. as seen at 25 cm. from the eye		11·7	13	14·3	16·8	24	33
		<i>Zeiss Compensating Eye-piece.</i>					
Magnifying power .. ..		× 2	× 4	× 6	× 8	× 12	× 18
Size of field in cm. as seen at 25 cm. from the eye		7·6	12·7	14·3*	12·3*	12·6	19

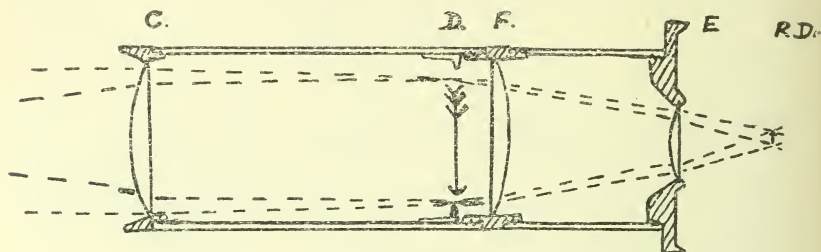
\* The break between these two readings is due to the change from Huyghenian to Ramsden type.

The restriction of the field of the low-power lenses is partially due to the limit set to the diameter of the lenses of the eye-piece by the internal diameter of the draw tube of the microscope, and partially due to the design, for in all the eye-pieces at present available (i.e Ramsden, Kellner, and Huyghenian) the illuminated area bounded by the eye-piece diaphragm must be considerably smaller than that of the largest lens found in the eye-piece.

For a larger field to be obtained, either the diameter of the draw tube must be increased or a different design of eye-piece employed. Such an eye-piece can be constructed with the approximate lens positions shown in the diagram.

All the lenses are ground from common crown glass. The lower lens or collimator is placed at such a distance from the objective that the back lens of the latter is at the former's lower focal plane; it therefore receives the divergent bundles of rays from the objective and renders them parallel. (The individual

rays in each bundle of course converge, to form an areal image of the object in the plane of the eye-piece diaphragm.) The rays now meet the middle or field lens and are rendered convergent by it as they pass toward the eye lens. (The latter causes a magnified image of the areal image produced in the plane of the diaphragm to be received by the eye in the usual manner.) An eye-piece of



C = collimator; D = diaphragm; F = field lens;  
E = eye lens; RD = Ramsden disc.

approximately six diameters magnification constructed on the above plan was found to have a field 50 p.c. larger in diameter (and therefore of 125 p.c. larger area) than that of the Huyghens type eye-piece of similar power. Further, it was parfocal with the Huyghens type, and was equally free from chromatic and spherical aberration and had a rather flatter field.

The new eye-piece had the following optical constants:—

	Collimator Lens	Diaphragm	Field Lens	Eye Lens	Ramsden Disc
Diameter ..	20 mm.	18 mm.	20 mm.	10 mm.	
Focal length ..	12 D		22 D	31 D	
Intervals ..	← 40 mm. →	← 5 mm. →	← 25 mm. →	← 12 mm. →	

Apparent diameter of field (at 25 cm. distance) = 18·4 cm.

Calculation shows that other eye-pieces designed on the same plan should have fields roughly 50 p.c. larger in diameter than those of the usual eye-pieces of similar power.

Compensating eye-pieces of similar design can be readily made by making the eye lens achromatic on Abbe's principle. An eikonometer with large field has been designed on a similar principle.

## X.—THE USE OF THE MICROSCOPE IN THE RUBBER INDUSTRY (EASTERN PLANTATIONS).

By HERBERT SUTCLIFFE, A.R.C.Sc., F.L.S., F.R.M.S.

(*Read April 19, 1922.*)

### TWO PLATES.

It may very often happen that certain defects appear during the course of the preparation of raw rubber, but such defects only become evident in the finished raw product. Usually these defects can be avoided by careful preparation, though under some kinds of weather conditions at least one defect may appear in the finished article in spite of every precaution taken to avoid it.

Generally speaking the best grades of raw rubber, as far as Eastern Plantations are concerned, consist of "pale crepe" and "smoked sheet." The preparation of these in the early stages is much the same in both cases, though in the later stages the treatment of the coagulum is different in each case.

Certain defects may appear in smoked sheet which would be difficult to find in crepe rubber, even though present in quantity.

By making use of the microscope it is possible to determine with more or less certainty what the faults are due to. Usually a 16 mm. objective and an X8 or X10 eyepiece will give sufficient magnification for most examinations, though in a few cases it may be necessary to use a 4 mm. objective.

### SMOKED SHEET.

One of the commonest faults met with in smoked sheet is the presence of minute air bubbles which appear as black specks when the sheet is held up and examined by direct transmitted light. When, however, the observer stands to one side, or turns the sheet slightly, the air bubbles, having a different refractive index from the rubber, appear as a much lighter patch. This is shown in fig. 1. When, however, the patch of bubbles is examined by reflected light it assumes a dull appearance, as though that part of the sheet still retained patches of undried rubber. Fig. 2 illustrates this appearance.

These two illustrations only show what is seen when the sheet is photographed in the ordinary way. In order to determine whether the patch is due to air bubbles or due to moisture in the

rubber, a small free-hand section, which need not be thin, of the patch is made and placed on a microscope slide and covered with a few drops of xylol. The rubber swells and becomes semi-transparent. After a few minutes a fairly thick cover slip is placed on the rubber and a gentle pressure applied to the cover so that a thinner film of rubber is formed. Examination shows the bubbles of various shapes and sizes, as illustrated in fig. 3. On gradually increasing the pressure on the cover-slip the air bubbles disappear, leaving a very thin transparent film of rubber.

Another defect which may appear in smoked sheet is what is known as "rust." When an apparently perfect sheet is pulled strongly, and afterwards allowed to return to its original shape, it is sometimes found that a thin film of dust or powder has made its appearance on the surface of the sheet. This defect is often called "stretching rusty."

The rust originates from the serum which remains on the sheet after the coagulum is taken out of the tank or pan. The proteids, etc., in the serum are decomposed by bacteria, but fungi, such as yeasts, etc., also may play an important part in this, the result being a film is formed composed of bacteria, fungus spores and proteid matter. Fig. 4 shows rust scraped from a slightly rusty sheet, while fig. 5 shows the same under a higher magnification. The rust was stained with cotton-blue before photographing.

Moisture in sheet can be readily distinguished from very small air bubbles when a small piece of the rubber is allowed to swell up in xylol; the water can be seen forming a very fine emulsion with the xylol. Fig. 6 illustrates this.

#### CREPE.

Dirt in either sheet or crepe can be shown by treatment with xylol and the application of a slight pressure, but in this case the dirt does not disappear as do air bubbles. The nature and origin of the dirt can usually be determined by this examination. Fig. 7 shows dirt in pale crepe. Fig. 8 illustrates the same with a higher power.

Very often the small particles are found to be due to small pieces of bark or cortex of the tree which have fallen into the

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#### EXPLANATION OF PLATE XII.

*Fig. 1.*—The appearance of bubbles in smoked sheet when examined by transmitted light.  $\times 2/3$ .

*Fig. 2.*—The appearance of bubbles by reflected light.  $\times 1/1$ .

*Fig. 3.*—Bubbles in sheet.  $\times 200$ .

*Fig. 4.*—"Rust" film from surface of smoked sheet.  $\times 46$ .

*Fig. 5.*—Rust film.  $\times 200$ .

*Fig. 6.*—Moisture in dry smoked sheet.  $\times 200$ .

latex, and have been ground up and incorporated in the dry rubber. Fig. 9 shows the angular appearance of the particles.

Another defect in rubber, from the point of view of its appearance, is spots due to the presence of moulds. This is of common occurrence on pale crepe. Fig. 10 is a photograph of a piece of clean crepe. Fig. 11 shows a similar piece of crepe which has been affected with moulds. Fig. 12 is a microphotograph of a small piece of rubber, after staining with cotton-blue and treatment with xylol, showing fungus mycelium.

In some cases surface defects may appear on both kinds of finished rubber which may have originated quite differently from the above-mentioned faults, such as films caused by vegetable debris in the water used in washing the rubber. This film may appear at first sight to be a simple case of rust due to serum, but microscopic examination shows at once the difference between the two films. In the case of other deposits micro-chemical analysis may have to be resorted to, especially when the deposit is only present in small quantities, as is usually the case.

#### DISEASES.

The part played by the microscope in the investigation of the diseases of *Hevea brasiliensis* is a very important one, but it differs very little materially from its use in the investigation of the diseases of other trees and plants cultivated for their economic products, so that it is unnecessary here to point out its essential use under this heading.

#### SUMMARY.

In the foregoing the use of the microscope has been shown to be of very great value in determining the causes and origin of the defects which appear in finished smoked sheet and crepe as put on the market. By the examination of these defects planters can be advised as to the best methods of eliminating the causes, and can offer to the buyers products which are of standard quality.

I am indebted to the Council of the Rubber Growers' Association for permission to publish this short paper in connexion with the use of the microscope in an important industry.

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#### EXPLANATION OF PLATE XIII.

- Fig. 7.*—Dirt in pale crepe rubber.     $\times 46$ .  
*Fig. 8.*—Dirt in pale crepe rubber.     $\times 200$ .  
*Fig. 9.*—Particles of bark in rubber.     $\times 200$ .  
*Fig. 10.*—Clean crepe.  
*Fig. 11.*—Spotted (mouldy) crepe.  
*Fig. 12.*—Section of spotted crepe.     $\times 200$ .

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## XI.—THE MICROSCOPE IN THE PAPER-MILL.

By JAMES STRACHAN, F.Inst.P., F.R.M.S.

(*Read June 21, 1922.*)

### 1. HISTORICAL.

THE Microscope appears to have been introduced to the paper industry early in the nineteenth century by paper-makers who were amateur microscopists. The writer has an old simple microscope which was used successively by three generations of an old Scottish paper-making family.

During the first half of the century, from the introduction of the paper machine about the year 1807 to the early fifties, paper was made in this country almost exclusively from rags, and the primary use of the microscope, that of distinguishing the vegetable sources of various fibres, was thus limited. In the second half of the century, however, which witnessed the introduction of straw, esparto grass, wood and other new raw materials, paper-making rapidly developed into one of the most important industries in Great Britain. During this period we established a world-wide reputation for the manufacture of fine paper, and this we still maintain.

With the introduction of new fibres, the use of the microscope in paper-making became more apparent, and when towards the end of the century paper-makers began to employ trained scientific men, the latter found this optical instrument already in extensive use in the industry. What the English paper-maker owes to the amateur microscopist, and exactly how much we are indebted to the latter, can hardly be appreciated at the present day. The writer has had occasion to enquire into the history of many of the pioneers of modern paper-making in this country, and he was surprised, but not astonished, to find that the majority were amateur microscopists.

The foundations of fibre histology were laid down by Quekett in his "Lectures on Histology" (1851), and were first applied specifically to the examination of paper by Suffolk in his "Microscopical Manipulation" (1869)—a series of lectures delivered before the Quekett Club. The scientific study of the microscopical examination of fibres from the technical side was continued in valuable publications by Wiesner (Wien, 1867) and Vétillart (Paris, 1876). The technology of paper microscopy was specially

developed in Germany by Herzberg (1888), Behrens (1896), and Hanausek (1901), and in Austria by v. Höhnelt (1888).

In this country much of the recent literature on the microscopy of paper-fibres has been borrowed from German text-books, but the scientific application of the microscope in practical laboratory work has been stimulated by a few well-known microscopists, among whom we may mention Christie (photo-micrographs) and Flatters (preparations), and by the work done in the laboratories of technical chemists connected with the paper-making industry; among the latter we find Cross and Bevan, Evans and Wirtz, Gemmell, Beadle and Sindall, all of whom have done much for paper microscopy by research work, publications and translations, and personal tuition.

## 2. ROUTINE WORK.

The microscope is generally used in the paper-mill laboratory, in the first place, for the identification of various fibres in common use, such as linen, cotton, hemp, esparto grass, straw, manila, jute, wood, etc. The pulped fibre is mounted temporarily in one of the numerous iodine stains, prepared specially for the purpose, and examined under a medium power; a good 16 mm. objective is the most useful lens for this work. The fibres are identified by their characteristic forms and markings, and the percentage composition of mixtures estimated to within 5 p.c. For accuracy in this work long experience and constant practice are necessary. It is a common experience to find random workers varying as much as 10 or 15 p.c. in their estimates of percentage composition. The differentiation and identification of fibres is used—

- (a) In the analysis of samples sent to the mill, for matching with orders; and
- (b) Controlling and checking the work of the practical paper-maker in his blending of various fibrous stocks.

The routine work in the average paper-mill laboratory also generally includes—

- (c) The identification of starches (used in sizing);
- (d) The examination of mineral powders (used as fillers), such as kaolin, gypsum, talc, etc.;
- (e) The identification of foreign matter, and tracing the origin of "dirt" particles in pulp and paper; and
- (f) In some mills the beating process and the reduction of fibre-length is partly controlled by microscopical observation. In mechanical wood-pulp mills the grinding is largely controlled by microscopical observation or projection by some form of the lantern microscope.

From my own experience of paper-mill laboratories I find few microscopists who attempt to extend their work much beyond the ground outlined above. Few also attempt to use the simplest form of microtome in spite of the fact that cross-sections may be quickly cut for temporary mounts of fibres, and much may be learned from same.

### 3. A PLEA FOR A WIDER APPLICATION OF THE MICROSCOPE.

The remarks I make under this head apply particularly to the paper-mill, but may also be studied with profit by workers in other industrial laboratories. A good training in practical microscopical technique is necessary, and a fairly wide knowledge of all branches of microscopical science desirable, together with a small but carefully selected bookshelf of reference works. The laboratory worker who desires to get the best out of his microscope should be able to mount and stain a bacterial film, stain and cut a vegetable section, grind a mineral section, prepare and etch a metal, and be conversant with the practical elements of microchemical manipulation. He should also have a good working knowledge of four methods of illumination—viz. direct light, reflected light, dark-ground and polarized light—and he should also be able to record his work with the camera.

The laboratory worker frequently pleads lack of time to study and cover such ground. I have found by experience and have always taught that such knowledge saves time. It is not necessary to aim at carefully prepared mounts for permanent collection. Speed, simplicity, a little care and practice are necessary. Every substance or material that comes to the laboratory for physical or chemical examination should first be submitted to suitable microscopical preparation and examination. The information so gained frequently solves problems qualitatively, leaving only the quantitative work to be done, and never fails to yield guidance for method in the latter work.

"What do you expect to see there?" I am frequently asked by someone when I take a substance to the microscope; something that is not usually examined microscopically. "I do not know," I reply, "but I expect to find something."

### 4. THE MICROSCOPE TEACHES THE VALUE OF DETAIL.

In the manufacture of paper numerous problems and difficulties arise. Some of the problems are chemical, some physical, and others physico-chemical. The processes of isolation of cellulose from raw materials by digestion and bleaching are largely

chemical. The beating process, whereby the cellulose is broken up mechanically and rendered colloidal to varying degrees, is largely physical. The processes of sizing and colouring paper-stock present numerous physico-chemical problems.

Variations in the methods of conducting such processes produce a variety of results which are taken advantage of by the practical paper-maker in the production of desired physical properties in the many kinds of paper made for particular purposes. The practical paper-maker works largely by rule-of-thumb methods based on past experience. If he gets a certain result by a process of trial ending successfully, to obtain the same result in future he will repeat the same process exactly, although in doing so he may perpetuate an indirect method involving useless error and correction.

The constant use of the microscope reveals the fact that all variations in the chemical and physical treatment of cellulose are accompanied by changes in the structures and micro-chemical properties of the fibrous material. Some of these changes are slight but perfectly definite when closely studied under the microscope. The importance of such detail is obvious. An exact knowledge takes the place of vague descriptions, and the peculiarities of masses thus described are more exactly described, and to some extent explained, in terms of the individual constituents and elements. In this work both polarized light and dark-ground illumination are almost indispensable.

Such a knowledge of detail gained by use of the microscope is invaluable when applied in the control of practical processes. The application of the microscope in this direction in the paper-mill is still in its infancy, but promises to be a most interesting and valuable field of work.

## 5. STUDY OF MICROSCOPICAL DETAIL WIDENS THE MENTAL OUTLOOK.

It is generally recognized that a continued study of detail is apt to dwarf the imagination, but when such study is developed over a wide enough field, and always with practical issues in view, the reverse is the case, and a correlated and collated mass of detail stimulates the imagination.

About twenty years ago I commenced the study of the peculiar dendritic growths arising in paper from particles of copper and bronze embedded in the fibres. These growths supplied the amateur microscopist with pretty objects, but were regarded as a bit of a nuisance by the practical paper-maker. My object in studying them was not so much their prevention, which is a simple enough matter, as the nature of the chemical reactions taking

place during their growth. The summary of the results attained, as read before the Royal Microscopical Society and published in the Transactions, shows how the long-continued study of the details of an apparently trifling matter indicates important conclusions concerning the deterioration of cellulose in modern paper.

A problem which has puzzled paper-makers and their chemists for nearly a century lies in the sizing of paper with resin. The resin is added to the pulp in the form of a soap (sodium rezinate and dissolved resin), and precipitated by the addition of aluminium sulphite in the form of aluminium rezinate mixed with free resin. The problem may be stated in the question, "Why does free resin alone, precipitated from the soap with sulphuric acid, yield a sizing effect which is not permanent?" Some years ago a German society offered a premium for a solution to this problem which has been propounded perennially without any reasonable solution forthcoming. Yet the solution is very simple, and I have observed it under the microscope to my own satisfaction. Resin *per se* precipitated and rubbed over the surface of the fibres, when dried behaves as a fluid and flows slowly into the capillary pores of the cellulose. A film of alumina precipitated and rubbed over the surface of the fibres forms a membrane impermeable to resin. Whether this film is of alumina or aluminium rezinate, or a mixture of same is immaterial, the fact is demonstrable. It is possible to have an unsized absorbent paper containing 6 p.c. of resin, and a similar paper made from the same fibre, very hard-sized and ink-resisting, with only 3 p.c. of resin, provided the alumina is there in sufficient quantity. Very careful observation is necessary in work of this kind. The microscopist must train his eye for fine detail. The moral of the story of the two microscopists—one who cannot see the flagellæ on a certain bacillus with a  $\frac{1}{12}$ th oil immersion, and the other who can see it plainly with an 8 m.m. objective—is always with us.

Many years ago when investigating the ash of the leaves from various trees and their silica content, I found in many cases a few puzzling objects in shape of very minute spherical particles of mineral matter. Later I found the same objects in the ash of various kinds of paper. As some of the papers were not of wood cellulose there was obviously no apparent connexion with the trees. I was interested to know where they came from. They were perfect spheres, highly siliceous, isotropic, and varied in colour from white to brown. Some time later I met my spherical friends again while investigating the dust falling from the air in a paper-mill. One of them on this occasion was found to contain a minute included gas or air-bubble. Here was a clue to their origin. They were silicates formed by fusion. A brother microscopist said they were meteoric dust, and showed me a mount collected from a roof. I, however, suspected a humbler origin,

namely, the mill chimney, and soon found that many tons of the mysterious spheres collected annually in the furnace flues, and that the smaller ones went up the chimney literally in millions. They were particles of the siliceous ash of coal, fused in the furnace gases and whirled in the spheroidal state by the draught into the cooler atmosphere. While the inference from this incident, concerning air-carried impurities in a mill making fine paper, is perfectly plain, the occurrence of this spherical glass dust in the atmosphere of manufacturing centres suggests the usefulness of enquiries in other directions. For example, what is the physiological effect of such dust on living organisms? What would take place on the leaves of trees sprinkled with such dust and exposed to sunlight, each little sphere acting as a "burning glass"? What is their effect when breathed into the human lung?

All paper-mills are troubled at some time with slimy growths in their water pipes. These give rise to dirty specks in the paper. They may be divided into two kinds, brown slime from fresh-water pipes, and grey or black slime from white-water pipes (conveying water containing cellulose in suspension). The paper-maker calls them "slime," and they are most difficult to get rid of. He doesn't know much about them except that they give trouble in making clean paper, and that they come and go mysteriously. I have found that both kinds of slime are growths of higher bacteria. The brown slime from fresh-water consists of iron bacteria, and the grey slime from white-water of bacteria that grow during the fermentation and decomposition of cellulose. Both are anaerobic and grow rapidly in a warm situation, especially in a slightly acid medium.

While much time is wasted in attempting to clean pipes in the paper-mill by mechanical means, much better results may be attained by studying the conditions that produce the growths.

All paper contains a small percentage of grit or sand. This is a subject that has not received the attention due to it, and it is one that can only be dealt with properly by the microscopist. The sources of this grit are numerous, and can only be traced up with the aid of a mineralogical microscope. A large proportion of the grit in printing-papers may be traced to the china-clay used in loading, and when excessive causes undue wear and tear of process-blocks. I have found a small percentage of grit in a foreign paper specially made for wiping the front lens of oil-immersion objectives. I do not advise the use of paper of any kind for cleaning photographic or other lenses.

And so on; in every department of a manufacturing process such as paper-making interesting applications of the microscope may be found, and the more detailed the study the wider the field.

## 6. MICROSCOPICAL RESEARCH IN THE PAPER-MILL.

In an Appendix to this paper I have given an outline of the field in which the microscope may be used in paper-mill work, including some suggestions for research work, for it will be found that up to the present time only about 20 p.c. of the ground covered in this outline has been thoroughly dealt with by microscopists.

There are several points, however, which require special notice.

An important field for research lies in microscopical observation of the effects produced by the beating process. The imparting of colloidal properties to cellulose pulp by mechanical treatment is accompanied by a structural disintegration of the fibre. The trend of modern technical opinion on the so-called "hydration" of cellulose is towards a chemical explanation, but from long-continued microscopical observations, with immersion dark-ground illuminations, combined with other experimental work, I am of the opinion that a purely physical explanation is sufficient, and that the minor chemical changes are incidental.

Another field almost untouched is the systematic association of variety in fibre structure with the physical characteristics of paper made from particular fibres.

Transparency and opacity to light, natural "bulk" and density, elasticity and brittleness, etc., etc., are properties associated in many cases with particular fibres, but the particular structures giving rise to such properties have not been fully and systematically investigated.

In this connexion the use of the microtome and the polariscope have proved fruitful in my own experience.

Paper making technologists all the world over are, and have been for over a century, searching for new sources of raw fibrous materials. In this subject many more failures than successes have been recorded. Undue prominence has too frequently been given the "yield" of cellulose as determined by chemical means without careful description and valuation of the cellulose from microscopical examination. Any plant yielding more than 35 p.c. cellulose is regarded as promising, provided that questions of quantity, transport and treatment are commercially solvent. Three of the most promising new fibres which are being experimented with at the present day are cotton-hull fibre (unripe cotton), bamboo and papyrus. Cotton-hull stock is a most promising material, yielding with proper treatment a strong fibre of good permanent qualities. Very fine printing-papers have been made from both bamboo and papyrus, but both of the latter contain a much larger proportion of non-fibrous epidermal and parenchymous elements than any other material in common use. The laboratory

yield from bamboo and papyrus, particularly the latter, is much higher than the practical paper-making yield. In practical work much of short brittle epidermal cellulose and the tender parenchyme tissues are broken up and lost. An extreme case of this kind is that of certain mosses available in large quantities and giving high yields of cellulose (40 to 45 p.c.), of little value for paper-making because of the shortness and minuteness of the disintegrated plant structures. Anything less than 1.5 m.m. in length has a low value for paper-making purposes.

On the other hand, careful treatment of such fibres, and special arrangements for retaining the delicate parenchyme cells in particular, may result in the production of papers having special properties not easily obtained by the use of other fibrous materials lacking such elements, with which they may be blended to get desired results.

There is perhaps no other material in more common use than paper in its many forms, yet there is no common substance which has received so little attention from the point of view of the criminal investigator. The examination of a very small piece of paper by a skilful microscopist, possessing a wide knowledge of paper and the paper trade, will yield a vast amount of information, which may yield valuable evidence in relation to circumstances.

In including these remarks on research I cannot help remarking upon a subject intimately connected with both paper and research—viz. the paper upon which the records of our research work is printed. A very large percentage of scientific journals and literature is printed on paper of little permanence. In view of the extensive nature of such publications, and the necessity of providing students and workers with their necessary literature at a reasonable price, it is out of the question to suggest that all such records should be printed on permanent paper of high quality, as some idealists have proposed. I am of the opinion, however, that all scientific societies, and journals containing records of research, should make provision for the printing of a limited edition of their literature on a permanent paper for filing in their own and other important libraries.

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## APPENDIX.

### OUTLINE OF FIELD OF WORK.

(Proposed basis for work of R.M.S. Paper Section.)

- A. *Standardization* in
1. Equipment and tools.
  2. Reagents.
  3. Methods of fibre analyses.
  4. Photo-micrographic records.
- B. *Fibre Analysis.*
1. Application of polarized light to fibre structures.
  2. " ultra-microscope "
  3. Effects of beating on minute structure of fibres.
  4. Recognition of fibre defects (e.g. over-boiling or over-bleaching).
  5. Search for new reagents to differentiate type celluloses.
  6. " " similar fibres (e.g. the well-known difficulty of hemp and linen.)
  7. Association of fibre forms with physical properties.
  8. Valuation of new materials from structure of cellulose.
  9. Examination of paper without destruction of sample (for criminological evidence).
  10. Fungi and bacteria that attack cellulose (in paper deterioration and purification of effluent waters).
  11. Chemical residues in pulp-paper, and their effect on paper deterioration.
  12. Action of writing-ink and printing-ink on paper.
  13. Botanical survey of fibrous structures of natural orders towards guiding searchers in the field for new paper-making fibres.
  14. The association of physical properties of special papers with microscopical characteristics.
- C. *Colloidal Physics. Chemistry of Cellulose.*
1. Structure of regenerated cellulose films and precipitates.
  2. Systematic examination of molecular condition of highly hydrated celluloses from various sources.
  3. Systematic examination of action of pure aniline dyes in (2).
  4. Preparation of crystallized cellulose (alleged to be already accomplished but unconfirmed).
  5. Attempted synthesis of cellulose.

D. *Application of Microscope to other Fields in Paper-Mill Work.*

1. Sizing materials and solutions—rezin, starch, gelatine, etc.
2. Loading               "               "—kaolin, gypsum, barytes, etc.
3. Colouring           "               "—organic and inorganic.
4. "Dirt" in pulp and paper.
5. Suspended matter in air.
6.               "               "               in water.
7. Elucidation of problem of "foam or froth."
8. Metallography of beater and refiner bars, machine wires, etc.
9. Examination of cotton and woollen felts and their defects.
10. Systematic examination and record of paper "defects" and complaints.
11. Examination of deposits occurring in paper-mill plant.
12. Application of microscope to problems of lubrication.

## SELECTED BIBLIOGRAPHY.

A fairly complete library covering the ground indicated in the foregoing runs into some 250 volumes. The following short list comprises a selection of those most useful to the student and worker :—

## BOTANICAL.

- "Botany of the Living Plant."—BOWER.  
 "Structural Botany."—SCOTT.  
 "Practical Botany for Beginners."—BOWER and GWYNNE ; VAUGHAN.  
 "Wood."—BOULGER.  
 "Cotton."—BALLS.  
 "Cellulose."—CROSS and BEVAN.

## MICROSCOPICAL.

*General.*

- "Microscopy."—SPITTA.  
 "The Microscope and its Revelations."—CARPENTER ; DALLINGER.

*Technique.*

- "Microscopical Research."—FLATTERS.  
 "Critical Microscopy."—COLES.  
 "The Microtometist's Vade-Mecum."—LEE ; GATENBY.  
 "Handbook of Photomicrography."—HIND and RANGLES.  
 "Principles of Photomicrography."—WEST.

*Paper and Fibrous Materials.*

- "Papierprüfung."—HERZBERG.  
 "Microscopy of Technical Products."—HANAUSEK ; WINTON.  
 "Die Mikroskopie der technisch verwendeten Faserstoffe."—V. HÖHNEL.  
 "Végétaux propres à la fabrication de la Cellulose et du Papier."—ROSTAING.  
 "Manual of Paper Technology."—SINDALL.  
 "Fibres used in Textile and Allied Industries."—MITCHELL and PREDEAUX.

*Chemical.*

- "Anleitung zur mikrochemischen Analyse."—BEHRENS.
- "Mikrochemische Analyse."—BEHRENS; KLEY.
- "Elementary Chemical Microscopy."—CHAMOT.
- "Reactions Microchimiques."—KLEMENT and RENARD.

*Miscellaneous.*

- "The Principal Starches."—GRIFFITHS.
- "Rock Minerals."—IDDINGS.
- "Minerals and the Microscope."—SMITH.
- "Metallography."—DESCH.
- "The Chemistry of Colloids."—TAYLOR.
- "Micro-Organisms and Fermentation."—JÖRGENSEN.
- "Iron Bacteria."—ELLIS.

NOTES ON MICROSCOPICAL EQUIPMENT.

1. More than one-half the microscopical work required in the paper-mill laboratory may be performed with a simple stand of heavy construction, having a large stage, fitted with a good rack and pinion coarse adjustment only, and equipped optically with the best 16 m.m. objective procurable, and X 10 eye-piece.

2. For other work this may be supplemented by a heavy laboratory stand such as is generally employed for bacteriological microscopy. Optical equipment: Abbe condenser, three objectives, viz. 30 to 40 m.m., 16 m.m., and 4 m.m., two eye-pieces, X 6, X 10.

3. Accessories: a simple microtome, simple dissecting microscope and accessories, usual reagent bottles and mounting equipment, polariscope, dark-ground stops to condenser, and coloured glasses. Micro-meter.

4. For research work I use three stands. For chemical work a stand as described in (1), fitted with tourmaline plates for polarized light. For examination of fibres and minerals under polarized light a small mineralogical stand. For high-power work and photo-micrography a large universal stand with every mechanical refinement of adjustment.

5. Optical equipment for research work. In addition to the foregoing, 6 m.m. or 8 m.m. and 2 m.m. semi-apochromatic objectives, a full set of eye-pieces up to X 15, projection eye-piece, achromatic immersion condenser, polariscope, dark-ground immersion condenser, illuminator for opaque objects, micro-spectroscope, a good oil lamp and light filters. Mechanical accessories: a photo-micrographic bench and camera, a good microtome, and the usual minor equipment as required.

6. Although extensive and expensive equipment is required for exhaustive work, it should be remembered that the bulk of all microscopic work is done with the simplest equipment possible. Refined equipment and special accessories should be kept in the background and only used when absolutely necessary. Speed and skill in manipula-

tion, so necessary in commercial work, are best attained with simple apparatus of good construction; the fewer complications the better. Manipulation of a universal stand for other than critical and fine work is a waste of time and unnecessary deterioration of fine mechanism.

#### NOTE ON THE REFRACTIVE INDEX AND MOUNTING OF CELLULOSE.

It is rather a remarkable fact that no research work appears to have been done on the refractive index of cellulose. In view of the fact that recent researches\* by the X-ray method appear to indicate that cellulose has a definite crystalline structure, this would seem to be a promising field towards establishing the molecular constitution of this substance, a question still unsettled.

The cellulose of fibres is doubly refracting, and on this account, as well as its minute structure, it is very difficult to determine the R.I. by the immersion method. It varies slightly with different fibres according to their purity and mineral content. Pure cellulose appears to have a R.I. of approximately 1.555 for daylight, so that the index of visibility of unstained cellulose is low in Canada balsam.

For temporary mounts unstained fibres in water, or iodine-stained fibres in saline solutions, such as Herzberg's modification of Schulze's solution, are most convenient, although the latter tends to distort the structure.

For permanent mounts the pure bleached cellulose is best stained with a basic aniline dye and mounted in xylol balsam. Magenta on account of its high R.I. is a suitable basic dye.

\* Herzog and Jancke.

## XII.—THE USE OF THE MICROSCOPE IN THE BREWING INDUSTRY.

By A. CHASTON CHAPMAN, Pres.I.C., F.R.S., F.R.M.S.

(Read June 21, 1922.)

IN no industry, perhaps, has the use of the microscope for research and for control purposes been directly responsible for greater technical advances, and indirectly for more far-reaching discoveries, than in brewing. Although the brewing of beer is one of the most ancient of the industrial arts, it was not until the year 1876, when Pasteur's classical work "*Études sur la Bière*" appeared, that crude and often costly empiricism gave way to scientific method and control in this and other fermentation industries. As the results of his investigations Pasteur was led to the conclusion that many of the "diseases" to which beer was liable were caused by micro-organisms other than yeast, and he embodied that conclusion in two famous sentences:—

(a) "Every unhealthy change in the quality of beer coincides with the development of micro-organisms foreign to brewer's yeast, properly so-called."

(b) "The absence of change in wort and beer coincides with the absence of foreign micro-organisms."

These two sentences may be taken as marking the transition from empiricism and chaos to science and order in brewing operations.

Although extended and modified as the result of subsequent research, they may be regarded as the foundation stones on which much of modern brewery practice is built, and without which real success, if attained at all, would be largely a matter of chance. Inasmuch as souring and some other of the more striking changes which occur when beer undergoes deterioration are due to the activity of bacteria, it was not unnatural that Pasteur's attention should be very largely concentrated on organisms of that class. He did not, as a matter of fact, overlook the possibility that certain of the yeasts might be technically pathogenetic, but it will be obvious that no definite information on this point could be forthcoming until some means had been devised for preparing them in pure culture as a preliminary to a study of the technical characters of the various species of organisms which at that time constituted "brewer's yeast, properly so-called." This achievement was due to the Danish biologist Hansen, who in 1879 showed how any

required quantity of yeast might be obtained, starting from a *single cell*. It was then found that certain species of yeast were as much to be feared as many of the bacteria, and that the number of microscopic enemies with which the brewer had to contend was greater than had been imagined. Thus, a species of yeast known as *Sacch. Pastorianus I* produces a nauseous bitter flavour and a disagreeable smell; *Sacch. Pastorianus III*, and *Sacch. ellipsoideus II*, persistent turbidity; *Sacch. anomalus*, a marked fruity flavour; *Sacch. ilicis*, a disagreeable bitter flavour; and *Sacch. fetidus*, stench.

In the course of his work Hansen found that morphological characters were frequently useless for the purpose of distinguishing between one species and another, for not only did many of these resemble one another somewhat closely in appearance, but the shape of any one species varied within wide limits, depending chiefly upon the conditions under which it had been grown. This method of obtaining pure cultures when used in conjunction with certain other methods of differentiation, such as the behaviour of the yeasts towards certain selected carbohydrates, and the optimum temperatures for ascospore and film formation, has enabled zymotechnologists to isolate and describe many distinct species, of some of which numerous varieties are known. It should be said, however, that only a few of these are of industrial importance.

Although the use of "pure"—that is, single-cell—yeast has been widely adopted on the Continent, attempts to introduce it into English breweries has met with much less success. One reason for this is that the conditions obtaining in most English breweries are such as to result in the production of a definite type of yeast, which gives the exact class of beer required, and which can without resort to pure culture methods be kept practically pure—that is, free from bacteria and foreign yeasts within the limits necessary for successful working.

It will be seen, therefore, that the main endeavour of the brewer must be to maintain his pitching yeast in a pure condition in the above sense—that is, he must take steps to protect it from infection with bacteria on the one hand, and from the intrusion of pathogenetic species of yeast on the other.

When it is remembered that these organisms—both bacteria and yeasts—may not only be derived from the plant, but are always present to a greater or less extent in the air, and that in the brewing of beer very large volumes of a highly susceptible liquid have to be dealt with, some idea of the difficulties of the modern brewer may be formed. The cooling and refrigeration of the wort in purified air, the scrupulous cleansing of all vessels with which the wort or beer comes into contact, and the systematic testing of materials are all necessary if disaster is to be avoided. In the majority of the larger breweries there are laboratories in

which both chemical and biological tests and investigations are daily carried out, and much of the time of the scientific staff has to be devoted to examinations of the yeast, to the forcing of beers as a test of stability, to the testing of the efficiency of the air-filters, and to the investigation of difficulties when such arise. In the case of breweries where there is not a resident scientific staff, arrangements are almost invariably made for the work to be done by some independent consultant. It will be seen, therefore, that the microscope is to the modern brewer what the compass is to the navigator. It is an instrument to which recourse is constantly being had, and without its aid the brewer, like the navigator without a compass, would speedily find himself on the rocks.

### XIII.—AN APPLICATION OF POLARIZED LIGHT TO RESOLUTION WITH THE COMPOUND MICROSCOPE.\*

BY DAN M. STUMP, B.S., M.E., F.R.M.S.

(Read October 19, 1921.)

ONE PLATE.

EARLY in 1917 the author was interested in the resolution of a dry mounted Fasoldt thirteen band ruling, and had succeeded in faintly resolving the tenth band with 114,000 lines to the inch, by using overhead oblique illumination and an objective of 1.40 numerical aperture.

The following brief note was noticed on page 325 of the 1891 edition of Carpenter's "The Microscope and its Revelations," ". . . when resolving striæ with oblique light the effect is much strengthened by placing a Nicol analysing prism over the eye-piece. . . ."

Applying this suggestion to the resolution of the Fasoldt ruling, when the prism was revolved to its position of maximum effect, the tenth band was found to be perfectly resolved, each line standing out clearly from the next, and by very careful adjustment, the lines of the eleventh band, with 127,000 lines to the inch, were faintly visible.

This result was so very gratifying that experiments were made upon a number of objects having minute periodic structure, and it was found that in all cases where the prism was set so as to pass light vibrating in a plane parallel to the striæ being shown, a clearer image of the striæ was formed than when the prism was not used. The best results were usually obtained when the prism was placed in the path of the illuminating beam.

Attempting to explain this phenomenon, it was experimentally found that the diffracted beam was polarized, the light vibrating only in a plane parallel to the rows of markings causing the diffraction. The theory was then advanced that the image of the structure near the eye-piece diaphragm was formed by the interference of the polarized diffracted beam with *only* that part of the incident beam vibrating in this same plane; and that the remaining components of the incident beam, not entering into the forma-

\* Extracts from a paper presented to the Armour Institute of Technology, Chicago, May 1, 1921.

tion of the image of the structure, naturally exerted an obscuring effect on the image, sufficient when this image was faint to entirely obliterate structure otherwise well within the resolving power of the objective.

The function of the polarizing prism then was to remove all of this excess light not entering into the actual formation of the image of the structure, preventing this obscuring effect, and so allowing images of maximum clearness to be formed.

A careful consideration of this analysis showed that by the use of a single beam of polarized light, the only improvement in any image that could be expected would be the sharpening of the striæ in one direction only. No advantage could be gained with an object having structure presenting the appearance of a crossed grating—that is, with two or more sets of superimposed parallel markings—since a single prism would at its best improve the definition in one direction only, and would probably destroy the images in other directions altogether.

Since this type of crossed structure is very common in natural objects, and at the same time presents considerable difficulty in resolution, especially when the interval of the structure approaches the resolving power of the lens in use, it was considered very desirable that a method be found by which the advantages of the single polarized beam could be applied to the resolution of structure of this latter type.

The idea then evolved of illuminating the specimen with as many separate beams as there were structural elements, each beam being polarized in the proper plane to form a clear image of its particular element. The final image would then be a composite, formed by the blending of several independent images, each showing some particular element in the structure. The formation of an image in this manner is merely a modification of methods ordinarily used, the optical principles involved being identical.

In June 1917, the accompanying photograph was made of the surface structure of the test diatom, *Amphipectura pellucida*, using two separate beams of oblique light polarized at  $90^\circ$  to each other. These beams were produced from two light sources, and directed through two Nicol prisms held in a proper position below the condenser of the microscope, by means of a cork mount inserted into the diaphragm carrier. With the microscope in a horizontal position, one of the beams was projected directly through one of the Nicol prisms, and the second beam was directed through the other Nicol prism by means of a small  $90^\circ$  reflecting prism placed directly below it.

Another very convenient arrangement of the illuminating apparatus giving sufficient light for all visual work is shown on the accompanying sketch. A low voltage gas-filled lamp, furnished by automobile supply houses, may be placed between the mirror

and the cork mounting holding the prisms. One beam passes directly from the lamp through one of the prisms, while the other beam is obtained from the same lamp by reflection from the mirror through the other prism. This latter method is desirable because of the ease and rapidity with which the relative intensity of the two beams may be controlled.

The method which is commonly used to resolve structure of this type is to adjust the illumination so that one large main beam and two diffracted beams at approximately right angles to each other emerge from the objective at the same time. With this method, however, not all of the light of the central beam enters into the actual formation of the image, and an obscuring effect on the image will always be present due to this excess light. When several orders of spectra are present this effect is not noticeable, but as the intervals separating the structure approach the resolving power of the lens in use, this obscuring effect becomes more and more pronounced.

The described method of removing this excess light by permitting two beams to be separately polarized, allows images of maximum clearness to be formed, their perfection depending upon the quality of the objective employed.

It is hoped that some part of this paper may be found both useful and instructive to workers with the compound microscope.

#### XIV.—THE PLUNGER-PIPETTE—A NEW INSTRUMENT FOR ISOLATING MINUTE ORGANISMS.

By PROFESSOR A. BROOKER KLUGH, Biological Dept.,  
Queen's University, Kingston, Canada.

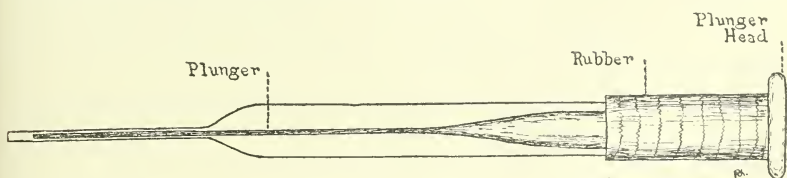
(Read June 21, 1922.)

ONE TEXT-FIGURE.

DURING the summer of 1921 I had occasion to isolate a large number of unicellular algae for the production of pure cultures, and this instrument, which I have named the Plunger-pipette, was originated to do this work with precision and celerity.

This instrument consists of:—(1) a piece of *thin*, soft glass tubing drawn to a capillary tube at one end; (2) a glass plunger drawn from a piece of glass rod to sufficient fineness to fit the capillary tip, and with a flattened knob at the other end; (3) a piece of rubber tubing which is placed so as to project beyond the glass tube.

In the figure the capillary tube is, for the sake of clearness, shown as relatively coarse, but in practice this tube should have an *inside diameter* of 80 *micra* or less.



These parts are so adjusted that the end of the plunger inside the capillary is about 1 mm. from the end of the capillary, while the knob rests against the rubber. This is accomplished by inserting the plunger (which should be made with the fine-drawn portion longer than required), and cutting off the part which projects through the capillary, then making the fine adjustment by moving the rubber slightly upwards.

The manner of using this instrument is as follows:—A drop or two of water containing some of the organisms it is desired to isolate is placed on a slide, the organism located, and examined with the 4 mm. objective and a X10, or higher, ocular. The desired organism is then located under the 16 mm. or 8 mm. objective. The pipette is held with the thumb and second finger just in front of the rubber, while the plunger-head is pressed with

the first finger so that the end of the plunger projects from the tip of the capillary. The end of the plunger is brought against the organism and the pressure of the first finger released, when the resiliency of the rubber withdraws the plunger and the organism is drawn into the end of the capillary. (If other organisms, or debris, lie close against the desired organism, they may be knocked away by shooting the plunger in and out by the pressure of the forefinger.) The organism is then transferred in the pipette to a hollow-ground slide containing a drop of the culture medium, and is ejected by a pressure on the plunger-head. It is then examined under high power to see that it is absolutely free from foreign organisms, picked up with the pipette as before, and transferred to the culture-vessel.

The chief advantages of this instrument are :—

1. The plunger does away with the drawing in of undesirable material by capillarity.
2. The plunger may be employed to clear other organisms away from the organism to be isolated.
3. The instrument is quick and certain in operation.
4. It is easily portable.
5. It is simple and requires no special attachments.
6. It is inexpensive, and several can be kept on hand ready for instant use in case of breakages.

## OBITUARY.

WILLIAM CARRUTHERS, PH.D., F.R.S., F.L.S., F.G.S.

WILLIAM CARRUTHERS, the doyen of the botanical world, died on June 2; he had just entered his 93rd year, having been born on May 29, 1830, at Moffat, in Dumfries. Educated at Edinburgh for the Presbyterian Ministry his interests, however, were such that he decided on following a scientific career. An acquaintance with Dr. Robert Chambers led to his contributing the geological articles to the first edition of "Chambers' Encyclopædia." In 1859 he became assistant (the only assistant at the time) in the Department of Botany of the British Museum, filling a vacancy caused by the death of the famous Robert Brown. In 1871 he succeeded J. J. Bennett as Keeper of the Department, and in the same year was elected a Fellow of the Royal Society. Almost his first official duty as Keeper was to appear before the Royal Commission on Scientific Instruction and to make a successful defence for the continued existence of his department at the British Museum. It was during his tenure of office (1871 to 1895) that the Natural History Collection was removed to the new museum at South Kensington (1881), affording an opportunity for improvement and expansion of which Dr. Carruthers was not slow to avail himself. One may say, in fact, that the arrangement and equipment of the galleries assigned to Botany at the museum form a lasting memorial of his knowledge and skill. Under his care the Herbarium was arranged and increased by the addition of many valuable historical collections; in the Department of Cryptogamic Botany he had the assistance of Mr. George Murray. With the aid of a large grant from the Treasury, and with his knowledge and appreciation of botanical literature, he was enabled to form what is perhaps the finest botanical library in the world. The rearrangement of the valuable collection of original botanical drawings and manuscripts was carried out under his superintendence. To his initiation we owe a series of valuable botanical monographs, of which two, Crombie's "British Lichens" and Lister's "Mycetozoa," were issued under his editorship.

Dr. Carruthers was elected a Fellow of the Linnean Society in 1861; from 1886 to 1890 he was President, and his term of service included the centenary celebrations of 1888. He represented the Society at the bi-centenary celebrations of the birth of Linnaeus in 1907, and his doctorate, Ph.D. of Upsala University, was conferred on that occasion. He was elected a Fellow of the Royal

Microscopical Society in 1880, and served in the office of President during the years 1900 to 1901, taking as the subjects of his Presidential Addresses the life and work of "John Ellis" (January 1900) and "Nehemiah Grew" (January 1901).

Carruthers was a botanist almost equally eminent in the systematic, palæontological and economic branches of the science. His most important contribution to pure science, "A Monograph of the Fossil Cycadean Stems of the Secondary Rocks of Britain" (published in the Transactions of the Linnean Society, 1870), from which the well-known genera *Williamsonia* and *Bennettites* date their origin, still remains a classic in palæobotany. In 1871 he was appointed Consulting Botanist to the Royal Agricultural Society, a post he held until 1910. His annual reports cover a wide field and form a valuable contribution to economic botany. When he began seed-testing on a very small scale in his own home in 1871 it was a real innovation in England, but under his hand it grew until now we have the important Institution at Cambridge of which he may well be described as the father. He devoted much time to the selection of grass for pasture and the guaranteed purity and germination of grass seed; he also conducted a classical series of observations on the vitality of farm seed.

He formed a fine collection of Puritan tracts, and continued to take a practical interest in the work of the Presbyterian Church in England, and for forty-six years edited their "Children's Messenger."

A. W. SHEPPARD.

SUMMARY OF CURRENT RESEARCHES  
RELATING TO  
ZOOLOGY AND BOTANY  
(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),  
MICROSCOPY, ETC.\*

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ZOOLOGY.

VERTEBRATA.

a. Embryology, Evolution, Heredity, Reproduction,  
and Allied Subjects.

**Irradiation of Young Guinea-pigs.**—M. FRAENKEL (*Strahlentherapie*, 1921, 12, 272; and *Journ. radiol. et electrol.*, 1921, 5, 429). Experiments with Röntgen rays on young or developing guinea-pigs. An animal was irradiated four times after birth. It remained abnormally small, but gave birth in normal time to two young ones. These, not irradiated, remained still small, and gave birth to young ones which were sterile. The absence of hair on the head and back, provoked in the first generation by the irradiations, recurred in the following generations. Autopsy of the animals showed a large accumulation of fat. Cystic degeneration of the ovaries was observed alike in the irradiated and non-irradiated animals.  
J. A. T.

**Effects of Altered Oxygen Pressure on Dove Embryos.**—OSCAR RIDDLE (*Proc. Soc. Exper. Biol. and Medicine*, 1921, 18, 102-5). Compared with hatched young or adults the dove embryo has very inferior powers of adjustment to either high or low oxygen pressures. The earliest stages, in fact, wholly lack the usual or other apparent mechanisms of respiratory compensation. Monsters result from altered oxygen pressure on young embryos. Age is the chief factor involved in the death or survival. Embryos of 8 to 10 days and older are like hatched individuals in being able to survive the highest percentages of oxygen. The youngest stages best survive decreased pressures of oxygen. For these stages the oxygen may be reduced to 9 to 10 p.c. for 24 hours. It is clear, however, that this "cold-blooded" stage of the bird embryo is unable to reduce the oxygen demands of the tissues to a further

\* The Society does not hold itself responsible for the views of the authors of the papers abstracted. The object of this part of the Journal is to present a summary of the papers as *actually published*, and to describe and illustrate Instruments, Apparatus, etc., which are either new or have not been previously described in this country.

reduction of the oxygen supply. In addition to the age-factor, which is most important, it seems that variations in the permeability of the eggshell to gases and the sex of the enclosed embryo are additional factors.

J. A. T.

**Hen-feathering induced in Male Fowls.**—B. HORNING and H. B. TORREY (*Proc. Amer. Soc. Zool. in Anat. Record*, 1922, **23**, 132). Fed daily with thyroid, in doses increasing with their weight, from the age of three weeks, Rhode Island Red chicks of male sex developed plumage of the female type, although males of this breed ordinarily do not pass through a juvenile stage characterized by plumage of the female type. The plumage of capons, usually ultra-male, is not affected. Castrated females which typically develop male plumage are similarly unaffected. The primary effect of the thyroid feeding seems to be to increase the activity of the "luteal" interstitial tissue of the testis. "The end result is a hen-feathered male resembling in all essential characteristics of the plumage the hen-feathered male of the Seabright and Campine breeds."

J. A. T.

**Gynandromorph Fowl.**—P. MURISIER (*Bull. Soc. Vaudoise Sci. Nat.*, 1921, **54**, 123-30, 1 fig.). A red Rhode Island fowl with somewhat cock-like characters in erectile organs and plumage, yet dominantly a hen. The ovary showed total degeneration as the result of a precocious tumour. In fact the animal had been pathologically castrated.

J. A. T.

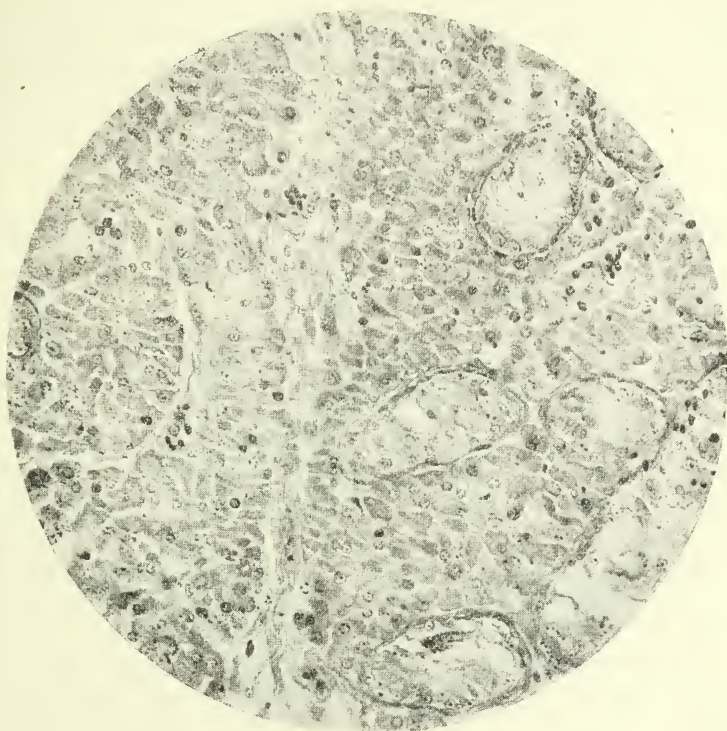
**Interstitial Cells in Testis of Guinea-pig.**—A. LIPSCHÜTZ, B. OTTOW, C. WAGNER and F. BORMANN (*Proc. Roy. Soc.*, Series B,



Two sections through the testis of a normal guinea-pig aged about  $4\frac{1}{2}$  months. On the left, interstitial cells in form of a triangle between tubules in full spermatogenesis; on the right, interstitial cells embedded in a granular mass in the neighbourhood of blood-vessels.

1922, **93**, 132-42, 2 pls.). In experiments with partial castration small testicular fragments show enormous hypertrophy of the interstitial

tissue, the number and size of the interstitial cells being very markedly augmented. The hypertrophy is not compensatory, as experiments



Section through a testicular fragment, showing enormous hypertrophy of interstitial cells, and the seminiferous tubules with only one stratum of cells.

clearly show ; it has nothing to do with the internally secretory function of the testicle in its relation to the organism as a whole ; it is caused by local conditions.

J. A. T.

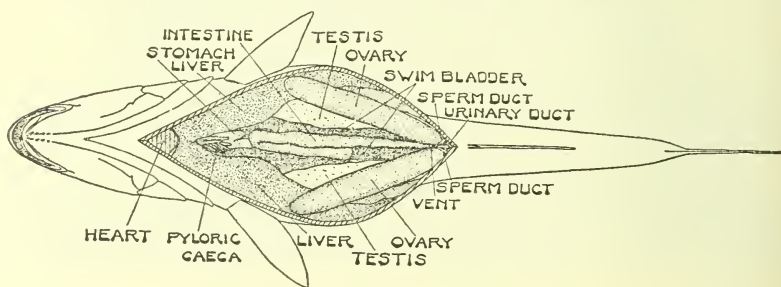
**Duck Hybrids.**—A. LECAILLON (*Comptes Rendus Acad. Sci.*, 1922, 174, 1431-3). Record of a male hybrid between *Dafila acuta* (male) and *Anas boschas* (female). This male hybrid had offspring by a female wild duck. The offspring produced fertile eggs. J. A. T.

**Inadequate Egg-shells in Pigeons.**—OSCAR RIDDLE (*Amer. Journ. Physiol.*, 1921, 57, 250-63). Individual female pigeons which occasionally produce soft-shelled eggs, and obviously thin-shelled eggs, may produce other eggs with normal or extra-thick shells. A very high proportion of the embryos which arise in all these groups of eggs die before hatching. The production of inadequate shells and the early

death of the embryo are thus causally associated, although the relative inadequacy of a particular shell is but loosely correlated with the death of the particular embryo contained within it. An unknown and more deeply seated cause is responsible for both the occasional inadequate or irregular shells and the numerous early deaths of embryos. Experience indicates that among pigeons the thin shells and associated early-dying embryos often occur after a long series of normal shells and viable young. After abnormally rapid reproduction there may be many such cases. The second egg of a clutch may be worse than the first, measured by the relative rate of the loss of water vapour through the shell. The second eggs are more likely to receive a slightly reduced relative amount of shell material. There may be some depletion in the mother's calcium supply; but there is some disorder in both ovum and oviduct. Several possible nutritional deficiencies have been investigated, but the real cause of the perturbation remains unknown. J. A. T.

**Differential Survival of Male and Female Dove Embryos in Increased and Decreased Pressures of Oxygen.**—OSCAR RIDDLE (*Proc. Soc. Exper. Biol. and Medicine*, 1920, 17, 88-91). If female embryos have a lower metabolism—i.e. lower minimum oxygen requirement—than males, the female embryos should withstand diminished pressures of oxygen somewhat better than male embryos. And male embryos should be better able to withstand an increased concentration of oxygen. Reduced metabolism induced by cooling should perhaps prove more harmful to the male embryos. The results of the experiments are not wholly decisive, but they give some evidence that sex is a factor in survival. The males best survive increased pressures of oxygen, and the females best survive decreased pressures and cooling. J. A. T.

**Hermaphroditism of a Croaker.**—C. M. BREDER, JUN. (*Zoologica*, 1922, 2, 281-4, 1 fig.). In a specimen of *Micropogon undulatus* two perfect ovaries and two perfect testes were found. The fish seemed to be about five years old, and had therefore passed through at least one



spawning season. The case suggests functional hermaphroditism. It is possible that self-fertilization occurred, or double mating. Most previous records of hermaphroditism in fishes tell of one set of gonads being much in advance of the other, but the ovaries and testes were practically equal in development in this case. J. A. T.

**Persistent Oviducts and Abnormal Testes in a Male Frog.**—D. R. BHATTACHARYA (*Journ. Asiat. Soc. Bengal*, 1920, 16, 293-6). In a male specimen of *Rana tigrina* were found a pair of persistent oviducts (though no ovaries), and a pair of testes of abnormally unequal size. The right testis was much smaller and the left testis much bigger than the normal, the former presumably arrested during growth. The oviduct on the right side was well developed, and that of the left small and degenerate, and not even continuous throughout its whole length.

B. L. B.

**Effects of Fat Excess on Tadpoles.**—R. MCCARRISON (*Proc. Roy. Soc.*, Series B, 1921, 92, 295-303). An excess of various fats in the food causes great retardation in the rate of growth. Iodine counteracted this in the case of some fats. The normal rate of metamorphosis was slightly affected by the harder fats, and delayed by the fluid and less saturated fats. The delay tended to be compensated for by small quantities of iodine in the case of some fats, not in the case of others. It seems probable that, in so far as certain fats—butter, lard, oleic acid, cocoanut oil, and arachis oil—are concerned, an iodine intake, proportionate to their intake in the food, is requisite for the maintenance of normal metabolism. The influence of cod-liver oil and of linseed oil, in further retarding growth in the presence of an amount of iodine that is favourable to growth in the case of other fats, is not as yet understood.

J. A. T.

**Sexes in Top-minnow.**—S. W. GEISER (*Proc. Amer. Soc. Zool. in Anat. Record*, 1922, 23, 112). In the progeny of *Gambusia affinis* reared in aquaria, with low mortality-rates, the proportions of the sexes are about equal. The adult males have a higher death-rate, and the inequality observed in natural conditions thus comes about. The gonads of the two sexes are at first indistinguishable; differentiation is seen in less than four weeks in the aquarium conditions. The anal fin in the male becomes an "intromittent" or copulatory organ (gonopod). In favourable conditions this is developed within the first three months; but it may be delayed for over a year. The length in both sexes is trebled or quadrupled in the first three months. Females born in May to June bear their first set of (viviparously produced) young ones when eight to ten weeks old.

J. A. T.

**Hermaphrodite Amphioxus.**—W. RIDDELL (*Ann. Mag. Nat. Hist.*, 1922, 9, 613-7, 6 figs.). Hermaphroditism in *Amphioxus* has been previously noted by Langerhans, Goodrich and Orton. In Riddell's case there were well-marked ova in one or both of the testes in some of the cross sections. In another section most of the testis is composed of ova in various stages of development. In another there was an apparently normal ovary on one side, and on the other a testis, which was almost normal, but showed one ovum. So that a series of gradations occurred. Some sections showed a mass of ova in the right metapleural space. Riddell inclines to regard his case as indicative of protandrous hermaphroditism.

J. A. T.

## b. Histology.

**Sharpey's Fibres.**—E. GRYNFELT (*Comptes Rendus Acad. Sci.*, 1922, 174, 966–8, 1 fig.). According to Kölliker and Ranvier the perforating fibres or Sharpey's fibres belong exclusively to the periosteal bone. There are connective bundles, more or less calcified, enclosed in the new formed matrix in process of ossification. But it seems that there are other perforating fibres which may be distinguished as *medullary*. They are much finer than the others; they are continuous with delicate collagenous fibres in the connective framework of the medulla. They are found on the surface of all the osseous lamellæ in contact with the medulla. Thus, taking the two kinds of perforating fibres, there is a penetration of the whole matrix from the periosteum to the medulla.

J. A. T.

**Ciliary Movement.**—J. GRAY (*Proc. Roy. Soc.*, Series B, 1922, 93, 104–31). The cilium is capable of expending potential energy in the form of work as long as it is in organic connexion with the cell protoplasm. Each ciliated cell of *Mytilus* is capable of independent movement when isolated. The cilia of the Ctenophore *Pleurobrachia* require a definite stimulus to induce their beat. The cilium is an elastic fibre or bundle of fibres, usually in communication with the cell protoplasm by intracellular fibrillæ. The beat consists of a rapid effective stroke and a slower recovery stroke. In an acid solution there is gradual slowing and then rest. The effect is reversible by alkalies. The rate of the beat is most simply controlled by controlling the hydrogen ion concentration within the cell. Under normal circumstances the activity of the *lateral* cilia depends on the presence of potassium ions. The cilia come to rest if the osmotic pressure of the external medium exceeds a certain value. A hypothesis is put forward that the mechanism of ciliary movement is essentially the same as that of muscular movement. The effect of ions on the cell-membrane has been studied.

J. A. T.

**Reaction of Frog's Melanophores to Pituitary Extracts.**—L. T. HOGBEN and F. R. WINTON (*Proc. Roy. Soc.*, Series B, 1922, 93, 318–29). Extracts of the posterior lobe of the pituitary gland have a specific effect on the melanophores of the frog, causing them to undergo extreme expansion. An injection, equivalent to less than  $\frac{1}{1000}$ th of the ordinary clinical dose, is adequate to produce a conspicuous darkening of the skin visible to the naked eye. The effect is the reverse of that which followed administration of adrenalin. The melanophore stimulant is only slowly destroyed by boiling with 0.5 p.c. hydrochloric acid; it is therefore different from the pressor principle, and in its slow destruction by acid hydrolysis agrees with oxytocic or uterine principle. It acts directly on the dermal melanophores rather than on the nerve endings.

J. A. T.

**Spiral Valve of Larval Lamprey.**—J. MAWAS (*Comptes Rendus Acad. Sci.*, 1922, 174, 1041–3). The lymphoid organ of the spiral valve of the *Ammocete* larva shows lymphoid tissue, a system of vessels and blood sinuses, and a partitioning connective tissue system—the

whole developing around the portal vein. Histological and embryological considerations lead to the conclusion that the structure is a sort of intra-intestinal spleen. The same holds for the lymphoid tissue developed in Myxinoids around the tributaries of the portal vein. J. A. T.

#### 7. General.

**Colloid Chemistry of Protoplasm.**—L. V. HEILBRUNN (*Proc. Amer. Soc. Zool. in Anat. Record*, 1922, **23**, 125). Experiments on the protoplasm of sea-urchin ova indicate that protoplasm is a positively charged colloid. But the surface layer is negatively charged, for the salts that coagulate the protoplasm cause the plasma membrane to swell, and those that liquefy the protoplasm tend to prevent this swelling. It is the electric charge that keeps colloidal particles dispersed through the liquid that contains them. J. A. T.

**Facial Hair in White and Negro Races.**—MILDRED TROTTER (*Washington University Studies*, 1922, **9**, 271–89). No sexual differences and no racial differences in the actual number of facial hairs have been found. The facial hairiness of man does not lend itself to Friedenthal's classification of human hair. There is no sexual difference in length or in diameter of facial hairs until after the tenth year of age. After this age the length of the facial hairs in the male greatly exceeds the length of the facial hairs in the female. The facial hairs of women of the white race slightly exceed those of the coloured race in length. After the tenth year the diameter of the facial hair in the male greatly exceeds the diameter of the hair in the female, but the smaller hairs in comparable regions of the face in the two sexes are similar throughout life. The hairs of the white race show a greater average thickness than the hairs of the coloured race. In both sexes of both races the upper lip is the region showing the most constant tendency for vigorous growth of hair. There is no constant difference in length or in diameter of hairs of dark-haired women and light-haired women, but dark-haired women often seem to have a heavier growth of facial hair, chiefly because of deeper pigmentation. J. A. T.

**Fat-soluble Vitamines in Marine Organisms.**—J. HJORT (*Proc. Roy. Soc., Series B*, 1922, **93**, 440–9, 13 figs.). Oils extracted from marine plants (green algæ) have been proved to have a very strong effect on the growth of rats fed on a diet deficient in fat-soluble vitamines, and it seems to indicate the working hypothesis that fat-soluble vitamines in the sea arise in plants as on land. Marine animals probably get these substances from the plants. Cod roe produced an immediate and rapid increase in the weight of rats, and drying does not destroy the growth-promoting factors. It is proposed to enquire into the influence of the food of marine animals on that periodicity in their growth which is so remarkable in northern waters. J. A. T.

**Seaside Notes.**—PERCY E. RAYMOND (*Amer. Journ. Sci.*, 1922, **3**, 108–14). A study of seashore phenomena from the palæontological side. Jelly-fishes on the shore, coated with driven sand, are far from

fragile. In a newspaper they persisted *in statu quo* for three months and more. The gelatinous material of the body cements the sand. Trails of *Littorina litorea* and *Lunatia heros* have been studied in relation to fossil trails, like Climactinities. Only one pre-Cambrian trail suggests a worm's burrow. The preservation of marine trails requires the postulation of some such processes as have been noted in connexion with jelly-fishes. J. A. T.

**Fixation of Fats by Cortex of Suprarenals.**—A. POLICARD and JULIANA TRITCHKOVITCH (*Comptes Rendus Acad. Sci.*, 1922, **174**, 960-1). The investigators have shown that the sebaceous glands are able to fix fats from the blood, and by means of the method of feeding mice with red-stained food they have shown that cells of the cortical zone of the suprarenal capsules with large adipose vacuoles are able to do the same. J. A. T.

**Functions of the Spleen.**—L. STERN and G. DE MORSIER (*C. R. Soc. Phys. Hist. Nat. Genève*, 1922, **39**, 29-30). Records of some experiments which support the theory that the spleen may function, through its hormone lienin, in maintaining the tonus of organs with smooth muscle-fibres. Removal of the spleen may throw more work on other organs, and notably on the suprarenal capsules. J. A. T.

**Habits of Tortugas Fishes.**—W. H. LONGLEY (*Proc. Amer. Soc. Zool. in Anat. Record*, 1922, **23**, 131). Various fishes occur in a "sand-patch association," being adapted to a substratum where they are concealed temporarily or in which they burrow. It is noted that *Thalassoma nitidus* seems to clean ectoparasites off other and larger fishes. These return again and again to submit to the process of grooming, and will drive others away which interrupt the attentions of the groom. This *Thalassoma* is closely resembled by a small blenny which, although rare, occurs along with it, and probably illustrates "Batesian mimicry." J. A. T.

**Poisoning Fishes with Lime.**—M. BORNAND (*Bull. Soc. Vaudoise Sci. Nat.*, 1921, **54**, 67-9). Experiments with goldfish showing the toxicity of lime, chloride of lime, hypochloride of lime, and calcium carbide. Poisoning with lime and calcium carbide is marked by a discoloration and ulceration of the gills, opacity of the eyes, and a corrosion of the epidermis. There is also a deposition of crystals of sulphate of lime in the gills after the addition of a minute quantity of sulphuric acid. J. A. T.

## INVERTEBRATA.

### Mollusca.

#### γ. Gastropoda.

**Five Years of a Self-fertilized Line of *Limnæa columella*.**—H. S. COLTON (*Proc. Amer. Soc. Zool. in Anat. Record*, 1922, **23**, 97). In 1911 a pond snail isolated in a vivarium laid a mass of eggs. The resulting young snails were isolated and cross-breeding prevented. Yet

for forty-seven generations of self-fertilization (ten years inbreeding of the closest kind) there has been no hint of any deterioration. The animal has "a great theoretical gametic purity, greater perhaps than any other animal which reproduces sexually." J. A. T.

**Circus Movements in Slug.**—W. J. CROZIER and W. H. COLE (*Proc. Amer. Soc. Zool. in Anat. Record*, 1922, **23**, 127). In the negatively heliotropic *Limax*, with non-directive illumination, the animal circles continuously toward that side on which the tip of the eye-tentacle (including the eye) has been removed. The diameter of the circular path varies inversely with the light intensity. The eyes or structures in their immediate vicinity are the effective receptors; upon regeneration of the eye after unilateral amputation there is progressive return of typical orientation. J. A. T.

**Gastropod Trails in Pennsylvanian Sandstones in Texas.**—SIDNEY POWERS (*Amer. Journ. Sci.*, 1922, **3**, 101-7, 3 figs.) Exposures of Lower Pennsylvanian sandstones at Shafter show trails which have been referred to Trilobites. But they indicate a single foot pressed deeply into soft mud and lightly into hard, mica-covered sand. Concentric ridges on either side of the central groove indicate the impression of the shell or body on each side of the foot. The probability is that the trails were made by Gastropods. J. A. T.

## Arthropoda.

### a. Insecta.

**Mimicry of Ants by other Arthropods.**—H. DONISTHORPE (*Trans. Entomological Soc.*, 1921, 307-11). Ants are on the whole well protected, so it is profitable for other Arthropods to be like them. 1. There are "simple" Myrmecoids, e.g. the little Locustid *Myrmecophana fallax*, which are not directly associated with ants. 2. There are Myrmecoid Myrmecophags which feed on ants, e.g. some spiders and tiger-beetles. 3. There are Myrmecoid Synechthrans which live with ants and feed on them, e.g. the jet-black *Myrmedonia funesta*. 4. There are partial Myrmecoid Synœketes, found in association with ants, but not feeding on them, e.g. *Gonatopus*. 5. There are Myrmecoid Synœketes, found always with the ants, e.g. the Staphylinid *Mimanomma spectrum*. 6. There are Myrmecoid Symphiles or true guests, e.g. *Lomechusa*. 7. There are Myrmecoid Entoparasites, which live with ants and lay eggs in them or their brood, e.g. the wingless *Mimopria ecitomophila*. 8. There are mimetic Formicidæ, e.g. *Colobopsis truncata* and *Dolichoderus 4-punctatus*. 9. There are Myrmecophile mimics of Myrmecophiles, e.g. *Coccinella distincta* like *Clythra 4-punctata*, both found in and about the nests of *Formica rufa*. 10. There are Myrmecophiles like inanimate objects, e.g. the guest *Anpholis*, like a bit of bark. J. A. T.

**Moving Flower-buds tenanted by Apion.**—K. M. HELLER (*Entomol. Mittheilungen*, 1922, **11**, 52-4, 5 figs.). Description of *Apion zikani* sp. n., the larva of which is found in the calyx of the flower-bud

of *Dalbergia foliosa* (Leguminosæ), and by its eating causes jumping movements like those produced in the "jumping bean" (*Croton colliguaja*) by *Carpocapsa saltitans*. J. A. T.

**Canadian Black Fly of Cattle.**—A. E. CAMERON (*Bulletin Canadian Department of Agriculture*, 1922, 5, 1-26, 9 figs.). An account of the structure, habits, and life-history of *Simulium simile*, common in Saskatchewan. The eggs are laid in gelatinous masses near the water-line of rapids; the larvæ form colonies on the stones and feed chiefly on diatoms; the pupæ are within shoe-shaped, coarsely woven, silken cocoons on the stones. There are probably four broods in the year. There is much mortality from desiccation. The swarms of adults may be carried ten or twelve miles from the river. The adult female is tenaciously parasitic on cattle and horses; it sucks blood from fore-quarters, under-surface, and inguinal region. The development of the ovaries depends on the engorgement. Man is not a host. Larvæ of may-flies and stone-flies devour the larvæ of *Simulium*, but the sucker-fish (*Catostomus commersonii*) is even more effective. "Smudge" smoke is a protection to grazing cattle and horses, and so is spraying with oily preparations. J. A. T.

**Life-history of Flies.**—E. ROUBAUD (*Comptes Rendus Acad. Sci.*, 1922, 174, 964-6). Many flies pass the winter as larvæ or as pupæ, and there is also adult hibernation. In many cases the winter "sleep" is not the direct result of cold; it is the expression of an internal rhythm. In *homodynamous* species—e.g. house-fly, *Stomoxys*, and *Drosophila*—there is uniform vital activity, except when the temperature is very low. In *heterodynamous* species—e.g. *Lucilia sericata*, *Mydæa platyptera*, *Sarcophaga falcitata*—there are stages of unequal activity in the annual cycle. Generations of rapid development, susceptible to thermal influences, are followed by a generation sharply punctuated by obligatory inertia or diapause, which sets in in autumn, but is not caused by the cold. The diapause is constitutional; the re-activation is induced by the cold. "Il faut l'hiver pour faire cesser le sommeil d'hiver." J. A. T.

**Dipterous Bat-parasite and a New Chalcid bred from it.**—F. W. URICH, HUGH SCOTT and J. WATERSTON (*Proc. Zool. Soc.*, 1922, 471-7, 1 fig.). The flying-fox, *Eidolon helvum*, of San Thomé is the host of *Cyclopodia greeffi* Karsch, an agile pupiparous Dipteron. The female attaches the full-fed newly-born larvæ, which immediately form a puparium, to parts of the trees where the bats sleep. From the puparia there were hatched out specimens of a Hymenopterous parasite, *Eupelmus urichi* sp. n., which might well, owing to its antennal and thoracic peculiarities, be made the type of a new genus. J. A. T.

**Sarcophagid Parasite of Field Cricket.**—C. A. HERRICK (*Trans. Amer. Micr. Soc.*, 1921, 40, 116-7). Larvæ of *Sarcophaga kellyi* were found inhabiting the general cavity of *Gryllus assimilis* at Manhattan. This seems to be a new case of parasitism in the black field cricket, but the same larvæ have been reported from grasshoppers, freshly moulted or inactive forms being chosen by the fly. J. A. T.

**Adaptations of May-fly Nymphs to Swift Streams.**—G. S. DODDS and F. L. HISAW (*Proc. Amer. Soc. Zool. in Anat. Record*, 1922, **23**, 109). The following methods of retaining position in rapidly flowing water have been observed in may-fly nymphs :—(1) Swimming species of fish-like (stream line) form swim well in still water, and the stronger swimmers invade the less swift portions of streams. (2) Species of fish-like form and small size have evolved strong legs with which they cling to rocks in the swiftest parts of torrential streams. (3) Flattened forms retain their position by (a) avoiding the direct shock of the water ; (b) flattening of head and legs in such an attitude that the force of water presses the animal against the substratum ; (c) the acquisition of sucking organs, developed from gills or the ventral surface of the abdomen ; (d) development of strong legs ; and (e) taking to crevices and thus avoiding currents. J. A. T.

**Metamorphosis of Coccids.**—PAUL MARCHAL (*Comptes Rendus Acad. Sci.*, 1922, **174**, 1091–6). Studies in the life-history of “earth-pearls,” *Neomargarodes trabuti*, from Algiers. In both sexes there are, to begin with, three identical stages :—(1) A primary, migratory, hexapod larva which reaches the host-plant : (2) an apodal, cystoidal, fixed larva, given over to growth ; and (3) a hexapod, mouthless stage, like a Melolonthoid larva. The female is neotanic and stops at this third stage. But the male continues to develop, and after two or three moults reaches the winged state—an instance of hypermetamorphosis.

J. A. T.

**Swiss Onychiurinae.**—E. HANDSCHIN (*Verh. Naturforsch. Ges. Basel*, 1921, **32**, 1–37, 2 pls.). A systematic account of this subfamily of Poduridae in the order Collembola. The members are marked by three positive characters—the presence of closable epidermic apertures or pseudocells, the complex structure of the antennary organ, and the complex primordium of the post-antennary organ ; and by four negative characters—the absence of eyes, the absence of clubbed setae on the tibiotarsus, the complete or almost complete absence of the spring-apparatus, and the absence of pigment in the majority. The genera are *Onychiurus*, *Kalaphorura*, and *Tullbergia*. J. A. T.

**Natural Enemy of the Castor Semilooper.**—T. V. RAMAKRISHNA AIYAR (*Journ. Bombay Nat. Hist. Soc.*, 1921, **28**, 298–300, 1 pl.). The semilooper caterpillar of the Noctuid moth *Achæa (Ophiusa) meilcerta* Hmp. is a common and well-known pest of the castor-oil plant all over India. This caterpillar is kept in check by a Hymenopterous parasite, which is described and identified as *Microplitis ophiusæ* sp. n. B. L. B.

**Butterflies of Mesopotamia.**—H. D. PEILE (*Journ. Bombay Nat. Hist. Soc.*, 1921, **28**, 50–70). Notes on forty-four species taken in Mesopotamia and forty-four others collected in the adjacent highlands of north-west Persia and Kurdistan, of which latter ten forms are new. In character the butterfly fauna of Mesopotamia, like the flora, which of course largely determines it, is much more English than that of the fauna of, say, the south of France. B. L. B.

**Alpine Orthoptera from Central Asia.**—B. P. UVAROV (*Journ. Bombay Nat. Hist. Soc.*, 1921, **28**, 71-5). Description of three new genera and species, *Orinhippus tibetanus* and *Dicranophyma hingstoni* belonging to the sub-family Locustidæ, and *Hyphinosmos fasciata* belonging to the sub-family Tettigoniidæ. The last named, found in western Tibet, is remarkable for occurring at the extraordinary high altitude of 15,000 to 16,000 ft.

B. L. B.

**Myiasis in India and Persia.**—J. A. SINTON (*Ind. Journ. Med. Res.*, 1921, **9**, 132-62, 4 pls., 8 figs.). Besides clinical notes on a number of cases, descriptions are given of the larva, pupa and adult stages of the flies *Pycnosoma dux*, *Lucilia serricata*, *Sarcophaga ruficornis*, and *Wohlfahrtia* sp.

B. L. B.

**"Penis" of the Bed-bug (*Cimex lectularius*).**—S. R. CHRISTOPHERS and F. W. CRAGG (*Ind. Journ. Med. Res.*, 1922, **9**, 445-63, 3 pls.). The female has two sexual apertures, a copulatory orifice and an orifice for oviposition. The so-called "penis" of the male is claw-like, carried laterally and bent to the left, in correlation to the position of the copulatory orifice of the female, and the position taken up by the pair during the act of copulation. The structure is not the penis at all, but merely a grooved director along which the true intromittent organ glides during the act of copulation. The *phallosome* had been overlooked so far. It lies at the root of the so-called penis and has all the chief characters of the phallosome in the order generally, though greatly reduced in size and complexity. The sexually modified segments of the female with their appendages are described and given their homologous denotation, in the light of comparative study and development.

B. L. B.

### β. Myriopoda.

**Conjugation and Reduction of Chromosomes in Scolopendra.**—P. BOUIN (*Comptes Rendus Acad. Sci.*, 1922, **174**, 968-70). In *Scolopendra cingulata* there is no interkinesis between the last gonial division and the spermatocytic prophase. The twenty-four chromosomes of the spermatogonia are transformed directly into the spermatocytes with twenty-four leptotene filaments, which conjugate in pairs, longitudinally, yielding twelve pachytene loops. After a stage of nuclear rest, twelve double filaments reappear, and these condense into twelve pairs of chromosomes in the form of rodlets. These divide longitudinally in the second maturation kinesis. The maturation thus occurs on the hetero-homeotypic plan, and the numerical reduction of the chromosomes is effected by the longitudinal conjugation of the spermatogonial chromosomes.

J. A. T.

**Myriopods from Mesopotamia and Persia.**—H. W. BROLEMANN (*Journ. Bombay Nat. Hist. Soc.*, 1921, **28**, 165-9, 2 pls.). A new Lithobiid, *Lithobius buxtoni*, distinguished from its nearest relative, *L. melanops* Newpt., by its rugose tergites and by the spinal armature of the legs, is described from Persia. The sexual characters of the female of *Strongylosoma persicum*, previously unknown, are described and illustrated, and certain blanks in Lignan's diagnosis of *Polyxenus ponticus* are filled up.

B. L. B.

## 5. Arachnida.

**British Trapdoor Spider.**—HUGH MAIN (*Essex Naturalist*, 1922, 20, 23-5, 1 pl.). An account of *Atypus affinis* in Epping Forest. It lives on gravelly banks, covered with tufts of heather. It makes a silken tube, which in the case of the mature female may extend three or four inches above ground, and eight to nine under ground. The tube is enlarged in diameter and length as the spider grows older, and Enock considered that individual spiders might live ten years. A swollen portion near the lower end may contain eggs or young. Main never found the male in the tube, but cases of this are known. The burrowing is done at night. The booty is caught in the aerial portion of the tube. J. A. T.

**Corsican Trapdoor Spider.**—W. MORTON (*Bull. Soc. Vaudoise Sci. Nat.*, 1921, 54, 113-5). Notes on *Ctenyza (fodiens) sauvagesi*. The lid is disguised with pieces of moss or lichen; there is a well-made silken hinge; the smooth silk-lined shaft is 18 to 20 cm. deep; there are minute holes on the under-surface of the lid for inserting the claws. The spider is nocturnal in its hunting. If a twig be pushed into the shaft the spider grips it with its mandibles and may be pulled out. J. A. T.

**Rare Spider.**—P. I. MERCANTON (*Bull. Soc. Vaudoise Sci. Nat.*, 1921, 54, 111). Notes on a rare spider, *Porhomma thorelli* (Herman), found in the salt mines of Bex and apparently confined to gypsum deposits. Although cavernicolous, it has normal eyes. It does not make a web, but uses a thread in ascending and descending. It was wrongly re-named (*Batyphantes charpentieri*) by Lebert in 1877. It has been known in the mines since 1867. J. A. T.

**Tracheal Tubes in Sarcoptidæ and Listrophoridæ.**—STANLEY HIRST (*Journ. Quekett Micr. Club*, 1921, 14, 229-36, 3 figs.). The mites of these two families are usually considered as Astigmata, without stigmata and without tracheæ. Mégnin figures a supposed stigma in *Chorioptes ecaudatus*, and Trouessart affirms his belief in the presence of stigmata in Analgesidæ and Sarcoptidæ. The presence of tracheal tubes has not been recorded for these families. But Hirst finds them in *Otodectes cynotis* var. *cati*, in *Chirodiscoïdes caviæ*, and in an undescribed Listrophorid mite. J. A. T.

**New Species of Arrhenurus.**—RUTH MARSHALL (*Trans. Amer. Micr. Soc.*, 1921, 40, 168-73, 3 pls.). Descriptions of new species of this genus of water-mites from Ontario, Woods Hole, Wisconsin, and China. J. A. T.

**Pycnogonids of Arcachon.**—L. CUÉNOT (*Arch. Zool. Expér.*, 1921, 60, *Notes et Revue*, 21-32). In this region there are five species, *Nymphon gracile*, *Ammonothea longipes*, *Anoplodactylus petiolatus*, *Chilophoxus spinosus*, and *Pycnogonum littorale*. There are seven at Luc and nine at Roscoff, but only two in the Baltic. There are many in the

Mediterranean, but Dohrn multiplied the number of species unduly. Some of the specimens of *Nymphon* bore Bryozoa, e.g. *Membranipora pilosa*; others showed Diatoms, Vorticellids, *Cothurnia*, and *Ephelota*.

J. A. T.

#### e. Crustacea.

**Observations on a Land Crab.**—L. E. CHEESMAN (*Proc. Zool. Soc.*, 1922, 361-3). Study of *Cardisoma armatum* from the river Gambia, but observed under the artificial conditions of the Caird House for Insects at the Zoological Gardens, London. The eyes only partially fill the large sockets. They function ineffectively in daylight, when the crab seems to rely on the abundant sensitive setæ. In the twilight the crab can focus with tolerable accuracy. The third maxillipedes, lined at the apex with very soft hairs, are used to clean the eyes and shade them. No response to sound was observed; the sense of taste and smell must be inside the mouth; tactile setæ are scattered over the limbs. The food consists chiefly of dead leaves and twigs, but fresh fish and mice are eaten. The whole mouse is gradually drawn into the mouth. Fresh water for immersion was preferred to salt water.

J. A. T.

**New Decapod Crustacean.**—ARATA TERA0 (*Annot. Zool. Japon.*, 1922, 10, 109-13, 1 fig.). Description of *Sympasiphæa imperialis* sp. n. found on the shore at Numadzu by the Crown Prince of Japan. Two other species have since been found. Of a brilliant scarlet colour, the new species is near *S. annectens* Alcock, but differs in definite details, such as the teeth on the carina.

J. A. T.

**Sex Dimorphism in Stomatopod.**—TAKU KOMAI (*Annot. Zool. Japon.*, 1922, 10, 101-7, 2 figs.). In the "flower mantis-shrimp," *Odontodactylus japonicus*, there is marked coloured dimorphism, such as Darwin referred to in his *Descent of Man* in the case of *Squilla stylifera*. In the male the dorsal surface is bright salmon-red; in the female the posterior half is bluish green. An interesting male specimen was found with the coloration intermediate between the typical coloration of male and female. This was probably to be associated with a defective development of hepatic organ and testes on one side of the body.

J. A. T.

**Intersexes in Gammarus.**—E. W. SEXTON and JULIAN S. HUXLEY (*Journ. Mar. Biol. Association*, 1921, 12, 506-56, 9 pls., 6 figs.). In stocks of *Gammarus chevreuxi* there were found thirty-two female intersexes. These usually resemble normal females in reaching maturity, but they gradually come to resemble males more and more closely. Finally, in size, general appearance, and mode of swimming they resemble males, while the structural characters (brood-plates, gnathopods, and sensory hairs) are intermediate between male and female, but to a varying extent. Characters which are never present in normal males, such as brood-plates, are present, together with others never present in normal females, such as gnathopod-size and shape, sensory spines, excessive hairiness of antennæ, etc., and, in extreme cases, curvature of the sensory hairs. One specimen produced fertile eggs: another mated

and produced unfertile eggs; another mated without result; the rest have never mated, either with males or females. The ovary is somewhat reduced. They occurred in three separate strains, also marked by cannibalism. A very slow attainment of maturity characterizes these intersexes, and a large final size. The continuance of the development of the female characters after the male characters have appeared is to be remarked. The interpretation proposed is that forms genetically female have been converted to a male type of metabolism during their life-history.

J. A. T.

**New Subterranean Amphipod.**—KOZO AKATSUKA and TAKU KOMAI (*Annot. Zool. Japon.*, 1922, 10, 119–26, 4 figs.). Description of *Pseudo-crangonyx*, a new genus of subterranean Amphipod nearly related to *Crangonyx*, e.g., in the uniramous condition of the third uropod, but differing definitely, e.g., in having the third uropod rather long and two-jointed, whereas it is short and one-jointed in *Crangonyx*. Three Japanese species are described from wells and an aqueduct.

J. A. T.

**Metamorphosis of Cyclops.**—ESTHER F. BYRNES (*Cold Spring Harbor Monographs*, 1921, 9, 1–19, 16 pls.). A finely illustrated account of the metamorphosis of *Cyclops americanus* and *C. signatus*. After the eggs have been extruded by the female they are carried about by her as egg-masses attached on either side of the abdomen. While so carried, the eggs undergo segmentation and subsequent development. The young hatch out as free-swimming nauplii. Nine stages are described as regards the appendages, and some interesting variations from the norm are recorded. One of the simplest ways of following the metamorphosis is to isolate individuals and to study the moulted cuticle. If the moult be studied at once it gives an accuracy of outline and detail that is difficult to obtain in the study of the living form.

J. A. T.

**Labral Glands and Mode of Feeding in Simocephalus vetulus.**—H. GRAHAM CANNON (*Quart. Journ. Micr. Sci.*, 1922, 66, 218–34, 2 pls., 2 figs.). The labral glands in this Cladoceran consist of a proximal and a distal group of gland-cells. The proximal group consists on each side of about twenty cells. These possess large flat nuclei, and their secretion collects as intercellular vacuoles. The distal glands consist on each side of four gland-cells and a duct-cell. The anterior pair of gland-cells possess large spheroidal nuclei between which is an ill-defined reservoir of secretion. The posterior pair have cup-shaped nuclei between which is a very definite reservoir of secretion. The duct-cell is a hollow tube. The duct-cells serve as ducts for the whole of the labral glands, the secretion passing as vacuoles from cell to cell. The duct-cell alters the reaction of the secretion before passing it to the exterior. Food particles carried in the stream due to the trunk-limbs are abstracted by the gnathobases of the second trunk-limbs. There are ten setæ on the gnathobase of the second trunk-limb; the anterior three are comb-like and brush the secretion of the labral glands on to the food-particles as they collect between the maxillæ. The setæ of the maxillæ pass the food on to the mandibles. Females stained

*intra vitam* with neutral red, when removed to fresh-water, will lay red eggs from which stained young will hatch. Agar's experiments are criticized. J. A. T.

**Early Development of Summer Egg of *Simocephalus vetulus*.—**H. GRAHAM CANNON (*Quart. Journ. Micr. Sci.*, 1921, 65, 627-42, 1 pl., 1 fig.). Each egg of this Cladoceran is laid in a yolk mass of foam, and subsequently forms a primary egg-membrane. Cleavage is completely superficial and apparently indeterminate. The first differentiation of the blastoderm is the appearance of a group of vacuolated yolk cells on the ventral side of the embryo. This is called the "ventral mass." It subsequently differentiates into a few large cells with very large nuclei which form the genital primordium, surrounded laterally and posteriorly by ectomesodermal cells, and anteriorly to this a mesendodermal mass of cells from which arises the mesendoderm. The genital primordium, surrounded laterally and posteriorly by inwardly growing ectomesodermal cells, invaginates and becomes internal by the lips of the invagination growing together and fusing. The mesendoderm grows backwards as a solid mass of cells, which subsequently spreads out flat and becomes indistinguishable from the laterally-lying mesoderm, and from this layer the endoderm separates as a solid rod in the median plane. J. A. T.

**Arctic Copepoda in Passamaquoddy Bay.—**A. WILLEY (*Proc. Amer. Acad. Arts and Sci.*, 1921, 56, 185-96). The plankton in this branch of the Bay of Fundy includes *Calanus hyperboreus*, *Euchæta norvegica*, and *Metridia longa*, three Arctic species. It is especially remarkable that the rare males of the hyperborean *Calanus* were found in comparatively shallow water a little above the 45th parallel of latitude. J. A. T.

**Adaptations in Copepods. Lazar Car.—**GLASNIK (*Rev. Soc. Nat. Croatica*, 1921, 32, 175-84, 3 figs.). An interesting essay on the detailed adaptations of the appendages and other external features of Copepods, showing that the joints, the spines, the setæ are mechanically effective. "The smallest spine and the minutest seta has its significance," and has been fashioned in relation to an end. The organism is purposive in relation to the differentiation of its organs, showing "intelligence without consciousness." J. A. T.

#### Annulata.

**Affinities of *Histriobdella homari*.—**F. MESNIL and M. CAULLERY (*Comptes Rendus Acad. Sci.*, 1922, 174, 913-7, 5 figs.). The maxillary apparatus in this interesting type is identical in plan, structure and connexions with that of Eunicidæ, and the resemblance points to genetic affinity. The cephalic appendages recall those of *Ophryotrocha*. The absence of a setigerous apparatus suggests simplification, but there is marked differentiation in the nervous and genital systems. It seems that the type should be regarded as a degraded Eunicid, and not as a primitive Archannelid. J. A. T.

**Histolysis and Phagocytosis in Cœlom of Mature Nereids.**—ARMAND DEHORNE (*Comptes Rendus Acad. Sci.*, 1922, 174, 1043-5). As Nereids become sexually mature there is a sarcolytic fragmentation of certain muscle-fibres, some of which seem to be derived from the intestinal musculature. There is a slow myolytic degeneration in both sexes during the process of maturation. The muscular debris is engulfed by leucocytes, and what have been called clæocytes are aged leucocytes laden with sarcolytes which they are digesting. J. A. T.

**Greenland Oligochæta.**—PAUL S. WELCH (*Bull. Amer. Museum Nat. Hist.*, 1921, 44, 269-74). The Crocker Land Expedition collected at Umanak in Greenland two recognizable species of Oligochæta—*Lumbriculus variegatus* (Müller) and *Mesenchytræus falciformis* Eisen—and an unidentified immature species of *Mesenchytræus*. In view of the meagre records from Greenland, even this small collection is of interest. J. A. T.

**Cocoon Formation in Limnatus.**—G. MATTHAI (*Journ. Asi. Soc. Beng.*, 1920, 16, 341-6, 1 pl.). Observations are recorded on cocoon formation in the common Lahore leech, *Limnatus (Pacilobdella) granulosa* Sav. The number of cocoons laid by a single leech during a period of one month (May-June) varied from one to four—viz. one cocoon by ten specimens, two by ten, three by two, and four by one specimen. Cocoon-laying appears to be induced by tendency to dryness and rise of temperature—i.e. by adverse conditions. From a cocoon three or four to fourteen young ones hatch out in about a fortnight. B. L. B.

**Conditions of Multiplication of Sagitta elegans.**—A. G. HUNTS-MAN and MARGARET E. REID (*Trans. R. Canadian Inst.*, 1921, 13, 99-112). The plankton of the Bay of Fundy is very poor in the larvæ of fishes. The bay is noted for its high tides, strong tidal currents, and prevalence of fogs. The surface water remains cool and very salt. The effect of these conditions has been tested in regard to *Sagitta elegans*, which is found generally along the Nova Scotia coast in the summer. It breeds successfully in the Magdalen shallows of the Gulf of St. Lawrence. It does not breed successfully in the Bay of Fundy, as shown by the predominance of early embryonic stages throughout the season, and by the scarcity of the young. "In the Bay of Fundy the very limited success in breeding is correlated with the attainment of a high temperature, with the development in deep water of a special surface layer, or with the presence of estuarial conditions. The population of adult forms is too great to be the result of local breeding, and must be considered as the result of indraughts around the southern end of Nova Scotia from somewhat distant waters." J. A. T.

#### Nematohelminthes.

**Strongylosis in Cattle.**—JAMES E. ACKERT and W. E. MULDOON (*Journ. Amer. Veterinary Medical Ass.*, 1920, 58, 138-46, 5 figs.). Account of an outbreak of strongylosis at Manhattan due to *Ostertagia ostertagi*. Forty steers were visibly affected, twelve seriously, nine

fatally. The most obvious symptoms were extreme emaciation, anæmia, and œdema in the submaxillary region, and, in advanced cases, profuse diarrhœa. The parasites are small, yellowish-white, hair-like Nematodes, about one-third of an inch in length. They form nodules on the abomasum walls and cause erosions of the mucous membrane. It is probable that infection is direct. The parasites are blood-suckers. Treatment is difficult and uncertain. The outbreak referred to is the second in the United States. The parasite has occurred also in Germany, England, Argentina and New Zealand.

J. A. T.

**New Species of *Mecistocirrus*.**—KAORU MORISHITA (*Annot. Zool. Japon.*, 1922, 10, 89-99, 1 pl., 1 fig.). Description of *M. tagumai* sp. n. from the stomach of cattle in Japan, a fourth species of the genus *Mecistocirrus*. The new species is most nearly allied to *M. fordii*, but is distinguished by the larger size, the presence in the female of a prominent dilatation in the posterior part of the body (where the lateral lines and rows of somatic muscle-cells undergo a remarkable change in direction), and the close proximity of the vulva to the anus. The longitudinal cuticular ridges are anteriorly 50 and posteriorly 34.

J. A. T.

**Nematode in Field Cricket.**—JAMES E. ACKERT and F. M. WADLEY (*Trans. Amer. Micr. Soc.*, 1921, 40, 97-113, 1 pl., 3 figs.). A new Nematode, *Cephalobium microbivorum* Cobb, was found at Manhattan in the ileum of *Gryllus assimilis*. The Nematode matures in the ileum; its eggs pass out and hatch in the soil; the larvæ are swallowed by the omnivorous cricket. In cultures the embryo was formed in two days.

J. A. T.

**New Species of *Œsophagostomum* from a Rodent.**—R. J. ORTLEPP (*Proc. Zool. Soc.*, 1922, 461-9, 6 figs.). Description of *O. xeri* sp. n. from the cæcum of a South African ground squirrel (*Xerus setosus*). It is closely related to *Œ. apiostomum*, but the spicules of the male are much longer, the tail of the female is much more abruptly pointed, and the distance in the female *Œ. apiostomum* from the anus to the tip of the tail is greater than from the anus to the vulva, whereas in the new form just the reverse is the case. Larval stages occur in nodules in the wall of the cæcum.

J. A. T.

**Lung Worm of Sheep.**—JOHN E. GUBERLET (*Proc. Amer. Soc. Zool. in Anat. Record*, 1922, 23, 120). Infestation with the Nematode *Dictyocaulus filaria* takes place through the mouth. Lambs to which the parasite was administered in the food for twenty days showed infection in many organs, including the lungs. But the larval worms do not enter the blood stream at once, they remain for a while in other parts, e.g. mesenteric lymph-glands, and then migrate in the blood to the lungs.

J. A. T.

**Control of Hookworm.**—W. W. CORT, J. E. ACKERT, D. L. AUGUSTINE, and F. K. PAYNE (*Amer. Journ. Hygiene*, 1922, 2, 1-16, 2 figs.). Description of an apparatus for isolating hookworm larvæ from considerable quantities of soil. It is possible to distinguish mature hookworm larvæ, both sheathed and unsheathed, from other

Nematodes in the soil, by their characteristic structure and movement. A slightly higher percentage of larvæ can be isolated from moist than from saturated soil. In soil with very finely divided particles the percentage of larvæ that can be isolated is less than in coarser soils. The apparatus can be used for other Nematodes in the soil. J. A. T.

**Chickens and Hookworm.**—JAMES E. ACKERT (*Amer. Journ. Hygiene*, 1922, 2, 26–38). An inquiry into the rôle of chickens in disseminating hookworms. The length of time required for food material to pass through the digestive tract of chickens ranges from two hours and forty minutes to sixteen or more hours. Hookworm eggs remain viable while passing through the alimentary canal of chickens and are able to hatch; they may produce infective hookworm larvæ when the fowl faeces are mixed with animal charcoal or soil. But the majority of the eggs come to nothing. Newly hatched larvæ swallowed by chickens can pass through the alimentary tract apparently uninjured. Sheathed hookworm larvæ swallowed by chickens fail to pass at once through the fowls uninjured. A comparison of the reduction of mature hookworm larvæ by fowls with the establishment of infective spots by them convinces the investigator that chickens are more beneficial than harmful in the control of hookworm disease in Trinidad. J. A. T.

**Pigs and Hookworm.**—JAMES E. ACKERT and FLORENCE K. PAYNE (*Amer. Journ. Hygiene*, 1922, 2, 39–50). An inquiry into the rôle of swine in hookworm dissemination. Human hookworm eggs swallowed by domestic pigs produce infective larvæ in five days during the rainy season in Trinidad. A high percentage of the eggs ingested produce infective larvæ. The free-range pig is an important factor in the dissemination of human hookworm eggs. Infective hookworm larvæ swallowed by pigs do not pass through unaltered in the excrement. Larvæ of *Strongyloides stercoralis* survive passage through the digestive tract of the pig and multiply in the faeces. The pigs become infected with this Nematode. A new species of hookworm, *Necator suillus*, is of common occurrence in the domestic pigs in Trinidad. J. A. T.

**Unsheathed Hookworm Larvæ in the Soil.**—W. W. CORT, D. L. AUGUSTINE, J. E. ACKERT, F. K. PAYNE, and G. C. PAYNE (*Amer. Journ. Hygiene*, 1922, 2, 17–25). Although various investigators have reported that mature hookworm larvæ lose their sheaths under certain conditions, it has been the general opinion that they live normally enclosed in sheaths. It was found by the investigators that in a series of soil samples examined from places polluted by people infested with hookworms a large proportion of the mature larvæ were without sheath. Also, in experiments on the conditions under which hookworm eggs hatch and develop, and on the migrations of the infective larvæ, it was found that in soil a large proportion of the larvæ soon became unsheathed. These findings suggest that it is a common thing for mature hookworm larvæ to lose their sheaths and continue to live in soil. Since most of the knowledge of the activities of mature hookworm larvæ has come from studies on sheathed forms, it will probably be necessary to revise some of the conclusions. J. A. T.

**Bursate Nematodes from Indian and African Elephants.**—CLAYTON LANE (*Ind. Journ. Med. Res.*, 1921, 9, 163-72, 6 pls.). Descriptions are given of *Pteridopharynx africana* g. et sp. n., *Quilonia africana* sp. n., and *Grammocephalus clathratus* from the African elephant, and *Grammocephalus varedatus* sp. n. and *Bathmostomum sangeri* from the Indian elephant. The new genus *Pteridopharynx* lies near *Murshidia*, being separated from it by the structure of the œsophageal cuticle, the almost complete fusion of the two outer branches of the dorsal ray, the delicate spicules, and the close approximation of anus and vulva. A new sub-family, *Æsophagostominae*, is established to include the genera *Murshidia*, *Quilonia*, *Amira*, and *Pteridopharynx*, in which the oral capsule is ring-shaped, and the sub-family *Strongylinae* restricted to those others in which the oral capsule is more or less cup-shaped.

B. L. B.

#### Platyhelminthes.

**Cercaria of Schistosomum spindalis.**—M. B. SOPARKAR (*Ind. Journ. Med. Res.*, 1921, 9, 1-22, 2 pls.). A detailed description is given of the morphological characters of the cercaria of *Schistosomum spindalis* (Montgomery), the identity of which was proved by raising the adult parasites from the larvæ and also by obtaining the larvæ from the adult. Comparing them with the cercaria of *S. japonicum*, the author finds several points of agreement—viz. the course and arrangement of the excretory tubules both in the body and in the tail, the two ciliated areas, the bladder, the "island," and the two excretory pores at the tip of the furci with their bulbous ends. Two points of difference are however noted. The character of the ciliated areas in the expanded portion of the main trunk in the body is different, and there are four pairs of flame-cells in the body of this species, while the Japanese species possesses only three. The common characters of the known human and animal schistosome cercariæ are also compared and summarized.

B. L. B.

**Furcocercous Cercariæ from Bombay.**—M. B. SOPARKAR (*Ind. Journ. Med. Res.*, 1921, 9, 23-32, 4 pls.). The importance of the furcocercous group of cercariæ lies in the fact that the larval forms of schistosomes or the bilharzial parasites of man, domestic animals and birds belong to this group. In this paper a description is given of a number of furcocercariæ which have been studied in detail. Particular attention has been paid to the excretory system, which is considered an important feature of these larvæ, and separate figures are given showing in detail the arrangement of this system in four different types. The author has assigned provisional numbers to each type, and avoided giving them specific names for the present.

B. L. B.

**British Fresh-water Triclad.**—HENRY WHITEHEAD (*Essex Naturalist*, 1922, 20, 1-20, 1 pl.). British planarians range in length from 12 mm. to 36 mm. Their structure is briefly described. The slime glands probably render the movements of the cilia more effective, and the secretion from the ventral surface probably prevents the coagulation of mucus from the lateral gland. Threads of mucus may be used by

the animal to lower itself through the water. The rhabdites form a sort of chain armour; they can be discharged, and produce slime on coming into contact with the water. Planarians sometimes creep along on the under-side of the surface film. When planarians—e.g. *Dendrocœlum lacteum*—are irritated, the gliding movement passes into one in which the body, with the head fixed to the substratum, is stretched fully and then contracted violently. All avoid the light. Some species dispose their long axis parallel to the direction of the current, the head facing up-stream—e.g. *Planaria alpina*, *P. gonocephala*, and *Dendrocœlum lacteum*; others—e.g. *P. torva* and *Polycelis nigra*—appear indifferent; *P. cornuta* reacts but feebly. The food consists of small crustaceans, insect larvæ, small worms, and sometimes dead animals, or even plants. The discharge of rhabdites entangles the prey. The proboscis is inserted into the victim. They can do without food for a year; the reproductive organs disappear first. They are very sensitive to slight changes of temperature, but the range differs considerably. The slimy secretion renders them unpalatable, but they may be eaten by newts, sticklebacks, and certain carnivorous insect larva. A description is given of the British species, and a diagnostic key.

J. A. T.

#### Echinoderma.

**Heat Production and Oxidation in Echinoid Egg during Fertilization.**—CRESSWELL SHEARER (*Proc. Roy. Soc.*, 1922, Series B, 93, 410-25). In this investigation an attempt has been made to measure the oxygen consumption of the egg of *Echinus miliaris* during fertilization and early development, and to compare it with the amount of heat liberated by the egg at the same time. The oxygen consumption was measured by a special pattern of the Barcroft differential manometer; the CO<sub>2</sub> output by the same instrument. The heat liberation was measured by use of the differential micro-calorimetric method. The fertilized egg in the first hour of development gave off roughly six to seven times more heat than the unfertilized egg, and consumed at the same time six or seven times more oxygen than the unfertilized egg. On the whole the heat liberation of the egg on fertilization rises steadily, reaching its highest point when segmentation has been completed and the free-swimming stage is reached. On fertilization a greatly increased liberation of chemical energy is brought about within the ovum, as is shown by the increased oxygen consumption and the greatly increased carbon dioxide output and heat liberation. As, however, the calorific quotient of the unfertilized and the fertilized egg-cell is approximately the same in both instances, little or almost a negligible quantity of this energy is expended in bringing about the visible morphological structure of the developing ovum. It is probably employed in keeping the living substance itself intact as a physical system.

J. A. T.

**Species of Stichopus.**—H. L. CLARK (*Bull. Mus. Comp. Zool. Harvard*, 1922, 65, 39-74, 2 pls.). Critical discussion of the species of this genus of Holothurians, well represented by conspicuous forms on weedy and sandy bottoms in shallow water throughout the Tropics.

They often contract to 50 p.c. or more, and the body-wall readily disintegrates, "which soon reduces the creature to a most repulsive mass of slime." Thus identification is not easy. The author deals with the systematic evaluation of size, colour, body-form, ambulacral appendages, Polian vesicles, gonads, and calcareous particles. It appears that the calcareous particles are the only structures upon which much reliance can be placed in distinguishing species, but the body-form and the gonads afford characters of real value in distinguishing the genus, and the Polian vesicles may also furnish a generic character. About a score of species are dealt with, and the new genus *Astichopus* is established.

J. A. T.

### Coelentera.

**Classification of Actiniaria.**—T. A. STEPHENSON (*Quart. Journ. Micr. Sci.*, 1921, **65**, 493-576, 20 figs.; 1922, **66**, 247-319). An important systematic revision. "It is possible to guess at a small plankton swimmer with eight tentacles and eight mesenteries, without much definiteness of musculature, and with bilateral symmetry, and contrasting with, not resembling, the cruciform Scyphistoma, which must have been quite an independent outcome of a Hydrozoan. This small creature would give rise to several types much like itself but with differences of detail, each of which would give rise to a main Anthozoan sub-class. Only the one which gave origin to the Zoonthactiniaria need be followed here. This stock seemingly shed out curiosities at first; some of them took to burrowing and life in cracks, and became vermiform, but did not amount to much (Edwardsiaria); others went in for colonialism and incrustation, and had fair success in a coral-like way (Zoonthinaria). The main line, however, divided fairly early into two great groups, the split being upon the rock of sluggishness and colonialism and skeleton-building versus comparative activity, specialization of the individual, greater muscularity, and no skeleton. The two groups are of course corals (Madreporaria) and sea-anemones (Actiniaria)." A few corals developed no skeleton, or lost it (Corallimorphidæ or Discosomidæ). The sea-anemones proper gave off experimental forms (Proanthæ and Ptychodactææ); the main line gave off two lesser lines (Athenaria and Endocœlactaria), and two great lines (Mesomyaria and Endomyaria).

J. A. T.

**New Fresh-water Medusoid from Japan.**—ASAJIRO OKA and MAGOROKU HAKA (*Annot. Zool. Japon.*, 1922, **10**, 83-7). Description of *Limnocoedium iseanum* sp. n. found swimming in an old well in the town of Tsu, Province Ise, Central Japan. It is near *L. kawaii* Oka, but differs in the structure of the velar statocysts (regularly spherical and confined to the base of the velum) and the manner of arrangement of the nematocysts on the tentacles. The largest specimens measure about 18 mm. across. It is highly probable that the unknown hydroid generation is hidden somewhere at the bottom of the well, which is about 2.5 metres in depth. The new species stands by itself, whereas *L. kawaii* and *L. sowerbyi* are more closely allied.

J. A. T.

**Notes on Adriatic Hydroids.**—K. BABIC (*Glasnik, Rev. Sci. Nat. Croatica*, 1921, **33**, 94–7, 3 figs.). Notes on *Tubiclava lucerna* Allman, *Campanulina paniculi* Sars, *Lafoča dumosa* (Fleming), *Gonothyræa bicuspidata* (Clark), and some other forms, including a species of *Laomedea* with sixteen sharp denticles at the margin of the theca. J. A. T.

#### Porifera.

**Restitution-bodies and Free Tissue-culture in Sycon.**—JULIAN S. HUXLEY (*Quart. Journ. Micr. Sci.*, 1921, **65**, 293–321, 2 pls.). Mixture of cells of dissociated tissues of *Sycon* in normal proportions may lead to normal regenerates, like post-larval *Sycon*, with spicules, osculum, and pores. There is a sorting-out of the dermal and gastral cells. The former produce a single-layered epithelium, below which spicules are subsequently formed, the latter a central mass which becomes a hollow one-layered sac. In the cavity of this sac the cells put forth collars and flagella. Their fate is not a function of their position in the whole, but of their nature. Free tissue-cultures of collar cells form spheres, which live for a considerable time, but do not regenerate or form spicules. All grades from these to masses with an excess of dermal cells may be formed. Restitution-masses may cohere and unify. Spontaneous segmentation into spherules may also occur in unfavourable conditions. The spherules usually secrete a gelatinous covering. They may differentiate a normal dermal epithelium. The bulk of the component tissue (presumably choanocytes) usually separates into its constituent cells after a time. Dedifferentiation of all cells takes place after dissociation of tissues, but it does not lead to a totipotent condition. J. A. T.

**Adriatic Sponges.**—K. BABIC (*Glasnik, Rev. Sci. Nat. Croatica*, 1921, **33**, 77–93, 9 figs.). A report on Adriatic Monactinellida (60 species) and Tetractinellida (22 species). Of these 82 forms, 25 Monactinellids and 7 Tetractinellids are new for the Adriatic, and 7 Monactinellids are new species. J. A. T.

#### Protozoa.

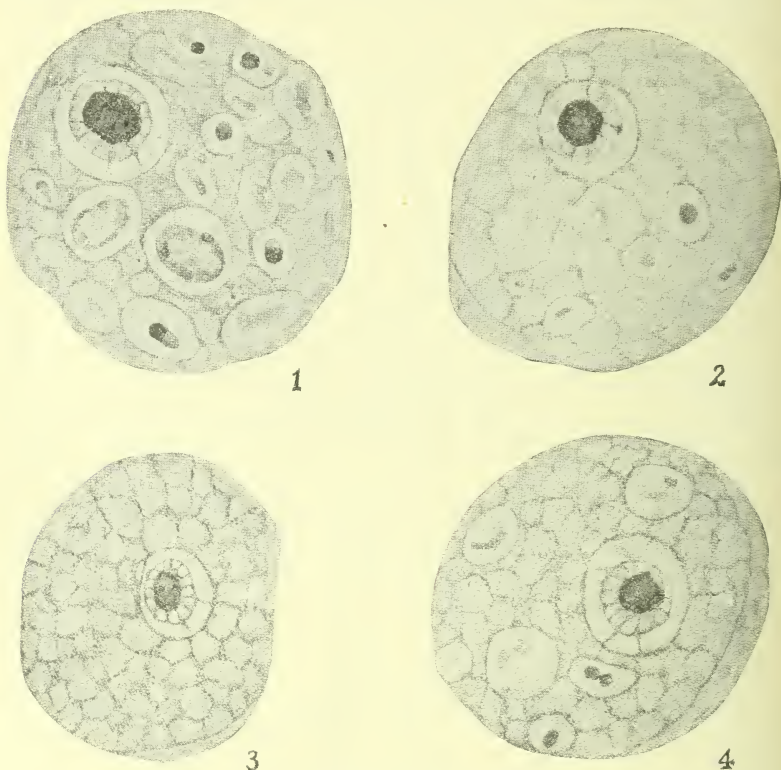
**Reactions to Light in Amœba.**—HARRY T. FOLGER (*Proc. Amer. Soc. Zool. in Anat. Record*, 1922, **23**, 128). Amœba reacts to sudden increase in illumination by complete cessation of movement, the time becoming shorter as the intensity increases, but not in precise inverse proportion. The reaction-time may be divided into a stimulation-period during which the amœba must be exposed to light if there is to be a response, and a latent period during which exposure is not necessary. There may be considerable changes in the length of the latent period. The stimulation-period varies inversely with the intensity of illumination. J. A. T.

**Influence of Temperature on Rate of Locomotion in Amœba.**—A. M. SCHWITALLA (*Proc. Amer. Soc. Zool. in Anat. Record*, **23**, 128–9). At a constant temperature there are alternate periods of acceleration and retardation in the rate of locomotion—phases of a locomotor rate-

rhythm, and coincident with eruptive and quiescent periods of activity. The average rate increases with a rise of temperature until a maximum is reached at about 25°, after which it decreases. It seems that the temperature affects the rate only through its effect on the rhythmical processes which condition locomotion.

J. A. T.

*Iodamoeba* of Man.—W. H. TALIAFERRO and E. R. BECKER (*Amer. Journ. Hygiene*, 1922, 2, 188-207, 2 pls.). A study of *Iodamoeba williamsi* and its cysts ("iodine cysts"). In the nucleus of the



*Iodamoeba williamsi*  $\times 4300$ .

FIGS. 1, 2.—Active amoebae stained with iron-haematoxylin and eosin. The peripheral granules of the nucleus appear as a segmented ring surrounding the karyosome.

FIG. 3.—Precystic amoeba stained with Mann's methyl-blue eosin mixture. Note the peripheral granules around the karyosome.

FIG. 4.—Active amoeba. Note the linin strands running from the karyosome to the nuclear membrane.

motile amoeba of the "iodine cysts" there is a well-defined nuclear membrane, a large central karyosome, a single layer of peripheral granules ("peripheral chromatin") which surrounds the karyosome,

and a few linin strands which run from the karyosome through the layer of peripheral granules to the nuclear membrane. The peripheral granules show a different staining reaction from the karyosome. The nucleus of the cysts contains the same structures as that of the motile amœba. The karyosome, however, becomes eccentrically placed, and the peripheral granules, which vary greatly in number among different nuclei, become localized on one side of the karyosome, between it and the nuclear membrane. The structure of the nucleus of the amœba of the "iodine cysts" makes it impossible to identify this form with *Endolimax nana* or to include it in that genus.

J. A. T.

**New Species of Valkampfia.**—A. CH. HOLLANDE (*Arch. Zool. Expér.*, 1921, 60, *Notes et Revue*, 33-42, 9 figs.). Description of *V. cruciata* sp. n. from the must of white wine. Among the generic characters may be noted the large karyosome sometimes with a centriole, the distribution on the nuclear membrane of fine granulations of meta-chromatin slightly siderophilous, the nuclear division after the premitotic plan, and the presence of uninucleate cysts. The new species is marked by the character of the cyst membrane—e.g. resistant to acids and bearing a cruciate mark. It develops well in an atmosphere of carbon dioxide. The only mode of multiplication observed was by the division of small amœbæ. It feeds on yeasts and on its neighbours. In contact with 3 to 4 p.c. solution of sodium chloride, the amœba ceases to form a cyst, and this "acquired character" may persist for several generations.

J. A. T.

**Food Reactions of Amœba proteus.**—W. A. KEPNER and W. CARL WHITLOCK (*Journ. Exper. Zool.*, 1921, 32, 397-412, 6 pls.). There are two general types of reaction to food: (a) when no contingency of escape is presented by the prey, the amœba tightly surrounds the food; (b) when such contingency is presented, a wide embrace is made and the prey is disturbed only when retreat is cut off. These two types of food reaction are not fixed, but vary greatly. In reacting to an object that usually moves in a horizontal plane, the amœba surrounds the prey in this plane first, and next cuts off its vertical paths of escape. A reaction is usually brought about through the co-operation of both ectoplasm and endoplasm, though the ectoplasm alone may carry out a reaction of the second type. Both the ectoplasm and the endoplasm are highly contractile when conditions demand it. The cutting of an animal like *Paramecium* into two is primarily a physical and not a chemical process—digestion setting in after the prey has been "defragmented." The process of ingesting food is a reversible one. Food half, almost, or wholly ingested may be egested. An amœba's reactions differ from physical and chemical phenomena in that they are qualitative rather than quantitative, and are made in the interests of the acting organism.

J. A. T.

**Foraminifera from Nigerian Eocene Clay.**—E. HERON-ALLEN and A. EARLAND (*Bulletin Geol. Survey Nigeria*, 1922, 3, 138-48, 1 pl.). A preliminary account of a small sample of clay from South Nigeria, collected by Sir Frederick Lugard. The sample furnished a few very distinctive and interesting forms, one of which, at least, *Virgulina*

*schreibersiana* var. *marginata* may be safely described as new. Two Miliolids, *M. sulcifera* (Roemer) and *M. bicarinella* (Reuss), have not been recorded since first described. The occurrence of *Peneroplis carinatus* d'Orbigny, recorded also from the Eocene of Selsey Bill, is noteworthy, as also is the fact that the only representative of *Bulimina* is *B. fusiformis* Williamson. The facies indicates shallow water and a temperate climate.

J. A. T.

**Structure of Shell in *Saccamina carteri*.**—W. J. SOLLAS (*Quart. Journ. Geol. Soc.*, 1921, 193–212, 1 pl.). Description of the intimate structure of this remarkable Foraminifer, which contributes largely to the formation of some of our Carboniferous Limestone beds. The mosaic structure of its wall may be regarded with great probability as being original, but there is much to suggest that the fossil was not an arenaceous form. Its alliance is possibly with the Calcareous Imperforata, and its name (to avoid identification with a living genus) should be changed to *Saccaminopsis*.

J. A. T.

**Foraminifera of Hartwell Clay.**—E. NEAVERSON (*Geol. Mag.*, 1921, 58, 454–73, 1 pl.). Thirty-six species, nineteen still living, are recorded from Hartwell Clay and associated Bononian beds. The assemblage is characterized by the abundance of rotulate Cristellarians of Lower Cretaceous type and of *Cristellaria fragraria*; the common occurrence of *Vaginulina harpa*, a Jurassic type; and the rarity of arenaceous and the absence of porcellaneous forms.

J. A. T.

**Relation between Growth and Nuclear Division in *Opalina*.**—R. W. HEGNER and HSIANG-FONG WU (*Amer. Naturalist*, 1921, 55, 335–46). A high correlation exists between nuclear number and cytoplasmic mass (as indicated by area) during the growth of the species of *Opalina* studied. By comparing the area of various stages with the number, size, state of division, volume and surface of the nuclei the following conclusions were reached:—(1) Nuclear division is stimulated by an increase of cytoplasm that may be determined approximately. (2) As the organisms increase in age the nuclei decrease in volume and surface. This is accompanied by a corresponding decrease in the area per nucleus, indicating that the nucleo-cytoplasmic relation is maintained. (3) Nuclear division is not synchronous because one nucleus is usually stimulated to divide before the others, and this division is sufficient for the time to re-establish the normal relation between nuclei and cytoplasm.

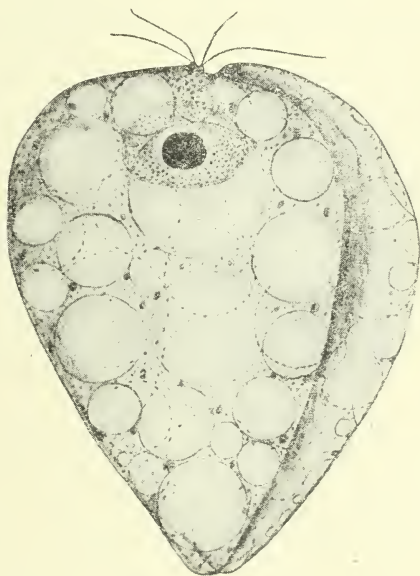
J. A. T.

**Treponema in Cells of Cerebral Cortex.**—Y. MANOUELIAN (*Comptes Rendus Acad. Sci.*, 1922, 174, 1134–6). In general paralysis the Treponema organisms penetrate into the cytoplasm of the nerve-cells of the cortex, especially into those of the second and third layer. It seems that the Treponema reaches the pia mater and traverses it, passes by the depressions of this membrane into the perivascular ensheathment of the cortex, traverses the lymphatic space, attacks the nervous tissue, causes lesions. Thus ensue syphilitic meningitis, lymphangitis, and encephalitis. But some Treponemas enter the cytoplasm, and are protected there from drugs. After exhausting the cytoplasm of a nerve cell the Treponema emerges and attacks another.

J. A. T.

**Size-variation in *Trypanosoma lewisi*.**—W. H. TALIAFERRO (*Proc. Nat. Acad. Sci.*, 1921, 7, 138-43). This flagellate is a non-pathogenic blood-parasite occurring in various species of rats, and disseminated by the rat flea. It reaches an "adult" stage in its development in the rat in about twenty-five days after it appears in the blood. Once this stage is reached there is practically no division or growth. Because of the elimination of growth factors, the organisms show a very low coefficient of variation in "pure line" infections, provided they are measured after the "adult" stage is reached. These facts make *T. lewisi* a very favourable organism in which to study size-variation. J. A. T. 21

**Binary Fission in *Callodictyon triciliatum*.**—R. C. RHODES (*Univ. California Publications, Zoology*, 1919, 19, 201-74, 8 pls., 4 figs.). This is one of the simplest Polymastigotes in structure and mitosis. The fission begins with an unequal constriction and differential division of the primary karyosome of the vesicular nucleus into a macrokaryosome and a microkaryosome, the latter alone functioning directly



Laterosulcar view of *Callodictyon*  $\times 1700$ , showing vacuolated cytoplasm, sulcus, vesicular nucleus, karyosome, two basal granules, four flagella.

in the formation of the prophase skein, which originates by the successive segmentation of the microkaryosome into two crescents and four terminal knobs. These crescents split longitudinally, producing eight or seven terminal knobs which are the elements at least of chromosomes. Coincident with the beginning of the segmenting skein, there is formed around the microkaryosome a kinetic membrane which expands till commensurate with the nuclear membrane. In the final prophase there

is a precocious splitting of the segmented skein, in which the number of terminal chromatin masses is doubled, and all are organized in an equatorial belt. The spindle is intranuclear. The centrosome is extranuclear. A typical parademesome is present. There is a blepharoplast of two basal granules, surrounded by archoplasm. In the middle of the prophase these granules divide into four. The flagella either split or grow out anew. The rhizoplasts split longitudinally. Division finally occurs by a longitudinal constriction along the sulcus. J. A. T.

**Variation in *Trypanosoma lewisi*.**—W. H. TALIAFERRO (*Proc. Nat. Acad. Sci.*, 1921, 7, 163-8). While growing the same "pure line" in different rats may cause significant differences in the mean size, these differences are small. The differences in the mean are never greater when the "pure line" is grown in different species of rat than when it is grown in different individuals of the same species. Passage of the "pure line" from rat to rat is not followed by any significant change in the coefficient of variation. But the passage of the "pure line" through the flea is invariably followed by a significant increase in the coefficient of variation. This is interpreted as showing that the "pure line" breaks up into heritably diverse lines following such passage. Although passage through the flea has such a marked effect on the variability, it has no significant effect on the mean size. "Wild" infections may consist of a "pure line" or a few pure "lines," which differ among themselves but are *per se* constant in size. J. A. T.

**Insect Flagellates.**—W. S. PATTON (*Ind. Journ. Med. Res.*, 1921, 9, 230-9, 3 pls.). First time that a species of *Herpetomonas* is described from one of the hæmatophagous species of the genus *Musca*. *Herpetomonas cragii* sp. n. is parasitic in the alimentary canal of the adults of *Musca bezzii*. The adult flagellate stage was found in the mid-gut in a few cases, and the post-flagellate stage in the hind-gut and rectum of about 75 p.c. of the flies examined. The mature flagellate measures from 20-25 $\mu$  by 1.5-2 $\mu$ . The nucleus is large and usually situated about the middle; the blepharoplast is small and lies close to the anterior end. Post-flagellate stages are also illustrated. Alimentary tracts of many larvæ of the fly were examined, but no stages of the parasite were found in them. Description is also given of the various stages of *Herpetomonas mirabilis*, found in the larva of *Lucilia argyri-cephala*, the infection being carried over to the adult stage through the pupa. As the result of certain transmission experiments and other observations, the author believes that species found in closely related Diptera are distinct, and not identical with those found in other species. Larvæ of *Musca nebulosa* were also found to be infected with *Herpetomonas muscæ domesticæ*, the infection being carried over to the adults.

B. L. B.

**Behaviour of *Herpetomonas tropica* in the Bed-bug.**—W. S. PATTON, H. M. LA FRENAYS, and SUNDARA RAO (*Ind. Journ. Med. Res.*, 1921, 9, 240-51, 2 pls.). As the result of previous work, conclusion was reached that in Cambay *Cimex hemiptera* appeared to be the only possible insect-carrier, and that the parasite is not transmitted by the bug in the act of sucking blood. A long series of experiments have

been carried out by feeding *Cimex hemiptera* on cultures of the parasite, and the conclusions arrived at that (1) the flagellates pass down to the rectum of the bug twenty-four hours after the feed; (2) in microscopic preparations the parasites can be found in the alimentary tract as late as the nineteenth day after the feed; (3) from microscopic examinations alone it would appear that the parasite disappears from the mid-gut, if the bug is not re-fed after the original feed on the culture; and (4) if a bug is re-fed again on clean human blood after a short interval, a large number of round growing flagellates appear in the mid-gut, and these, by multiplying, produce an intense infection. Various parts of the alimentary tract of bugs fed on cultures of the parasite were also cultured on the N N N medium. It was thus found that *H. tropica* can live for 23 days in the alimentary tract of starved bugs; for 34 days in the stomach of re-fed adult bugs; 44 days in the hind intestine, and 34 days in the rectum. It can live for 31 days in the mid-gut of a re-fed nymph; 36 days in the hind intestine and rectum; and for at least 9 days in the mid-gut of a bug fed as a larva. B. L. B.

**Behaviour of *Herpetomonas donovani* in the Bed-bug.**—W. S. PATTON, H. M. LA FREN AIS, and SUNDARA RAO (*Ind. Journ. Med. Res.*, 1921, 9, 252-4). Adult bugs were fed on cultures of parasite of Kala-azar, and various parts of the alimentary tract cultured on the N N N medium at varying intervals after the infected feed. The parasite can live as long as 41 days in the mid-gut of *Cimex hemiptera*, even though the bug be fed six times on clean human blood after the one infected feed. B. L. B.

***Nuttallia ninense*.**—J. A. SINTON (*Ind. Journ. Med. Res.*, 1921, 9, 359-63, 2 pls.). Description is given of this parasite as seen in smears from the blood and organs of two hedgehogs (*Erinaceus* sp.) at Kohat in the North-West Frontier Province of India. The author considers the parasite the same as that described by Yakimoff in *Erinaceus europæus* from Saratow in Russia, and called by him *Piroplasma ninense*. B. L. B.

**The Kala-azar and Oriental Sore Problems.**—W. S. PATTON (*Ind. Journ. Med. Res.*, 1922, 9, 496-532, 6 pls.). The parasites of Kala-azar and Oriental sore belong to the genus *Herpetomonas*. Reference is made to Wenyon's remarks on the justification for establishing the genus *Leishmania*, but according to the author Laveran and Franchini have conclusively proved that more than one species of true *Herpetomonas* parasitic in an insect can live and multiply in the organs of laboratory animals in which they produce lesions similar to those of Kala-azar and Oriental sore, and smears from these organs show the parasites infecting the cells, similar to those of Kala-azar in the cells of the organs of man and indistinguishable from them. The possible routes by which the parasite of Kala-azar can leave the human body are discussed, and blood-sucking insects other than bed-bugs are rejected as possible transmitters of the disease. When the bed-bug (*Cimex hemiptera*) was fed on the peripheral blood of a case of Kala-azar containing many parasites, the parasites slowly developed into flagellates in the mid-gut as soon as the cells containing them were digested, and

if the bugs were not fed again, the flagellates after multiplying rounded up again. When bugs heavily infected with flagellates are allowed to feed on clean human blood, in a large percentage the flagellates are destroyed and disappear. If the flagellates had succeeded in rounding up, they were able to multiply when the bug fed again. In what stage is the parasite likely to enter the human skin? The author refers to the work of Cornwall and of Mrs. Adie on the "thick tail" stage of the parasite, which is an intracellular stage. The author confirms Mrs. Adie's discovery, and has observed the process of thick tail formation in the cell, and the division of the parasite within the sheath. As the thick tail formation is not seen in the gut of any other blood-sucking insect, and the change does not take place when the flagellates in a culture are treated with the mid-gut of either *Pulex irritans* or *Pediculus hominis*, the author regards this as "*the final proof that Cimex is the true invertebrate host of Herpetomonas donovani.*" It is believed that *H. donovani* is acquired by man when an infected bug is crushed on the skin, the infective stage gaining entrance into the puncture produced by the proboscis of the crushed bug, or into a minute abrasion. Regarding *H. tropica* also, a similar intracellular stage is described. The flagellates here also, on entering a cell of the mid-gut of *Cimex*, develop a sheath, and then curling up become round; the movements of the flagellum within the sheath produce the characteristic thick tail. The encapsuled flagellate while coiled up in its capsule divides, and several daughter flagellates are produced (intracellular multiplication), which in time leave the cell by the rupture of the capsule. In this case also the infected bug is supposed to carry the infection by being crushed on the skin, no parasites having been found in the salivary glands.

B. L. B.

**Giardia (Lamblia) intestinalis in Children.**—K. F. MAXCY (*Bulletin Johns Hopkins Hospital*, 1921, **32**, 166-70). This Protozoon parasite is present in the intestinal tract of a large percentage of apparently normal children. It is rarely found before the first year. The percentage of infestations appears to be much higher in childhood than in adult life. In certain rare instances the parasite may be responsible for some intestinal disturbance, but the point has not yet been firmly established. There is no evidence as yet that any of the drugs used to clear out *Giardia* is of the slightest use.

J. A. T.

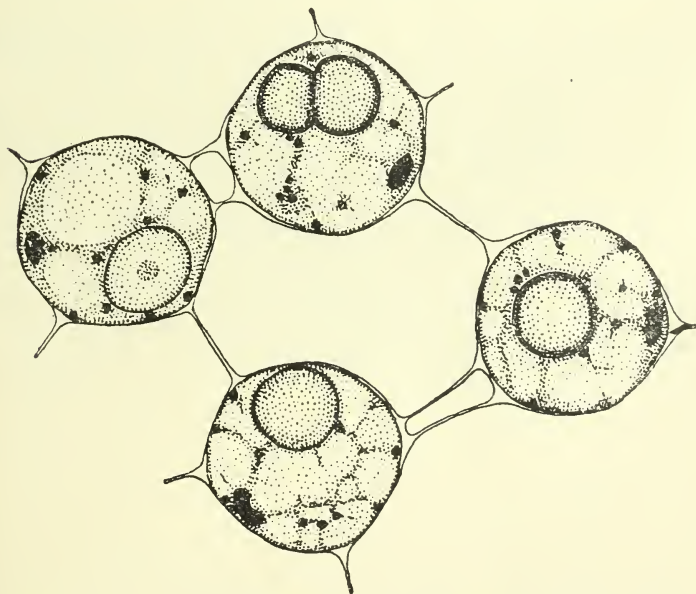
**Gregarina sænuridis and its Host.**—JEAN DELPHY (*Comptes Rendus Acad. Sci.*, 1922, **174**, 1644-6, 1 fig.). This Gregarine described by Kölliker in 1848 does not seem to have been seen since, but it is very common in a limicolous marine Lumbricid, *Pachydrilus verrucosus* (= Kölliker's *Sænuris variegata*). The parasites occur right through the body, all the year round. The trophozoite stage is rare; it must be passed through quickly. The trophozoites are often longitudinally apposed in syzygy; but isolated individuals also occur. There is a *Monocystis* stage and a *Zygocystis* stage. The parasite is very different from *Urospora sænuridis* Ray Lancaster, which occurs in *Tubifex*. Its spores are not appendiculate. There may, in rare cases, be solitary

encystations, and there are certainly double encystations without conjugation. The parasitized worms may have *Anoplophrya pachydrili* in the intestine and another species in the cœlom. J. A. T.

**Spores of *Leptotheca ohlmacheri*.**—R. KUDO (*Trans. Amer. Micr. Soc.*, 1921, 40, 161-7, 1 fig.). Ordinary fixation causes about 14 to 22 p.c decrease respectively in the sutural diameter and breadth of fresh, mature spores of this Myxosporidian. The possibility of calculating the dimensions of fresh spores from those of fixed and stained spores is discussed. The decrease in the dimensions of spores is due to the shrinkage of the entire spore body. Fixation makes the coiled polar filament invisible. J. A. T.

**Myxosporidian of Frogs.**—R. KUDO (*Proc. Amer. Soc. Zool. in Anat. Record*, 1922, 23, 121). In many specimens of *Rana clamitans* and *R. pipiens* there was infection with *Leptotheca ohlmacheri* in the kidney. A new host seems to be infected by the mouth. The spores germinate in the stomach; the amœbæ migrate into the cœlom and thence into the kidney, where complicated changes occur. J. A. T.

**New Dermocystidium in Frog.**—E. GUYÉNOT and A. NAVILLE (*Revue Suisse Zool.*, 1922, 29, 133-45, 5 figs.). Members of this



Four spores of *Dermocystidium ranæ* connected by delicate filaments.

genus have been previously observed on the skin of newts and the gills of Salmonidæ. A new form, *D. ranæ* sp. n., is described from *Rana temporaria*, occurring in cysts in the skin, each cyst bent like a U. The

spores within the cyst show an areolar proplasm with granulations, an excentric nucleus, and a central body. The development of the central body is described. It begins as a cluster of eosinophilous granulations, which form a group of vesicles, and these condense into a large spherical body with a concretionary concentric structure. The spores within the cyst are often united in groups by delicate strands. J. A. T.

**Eimeria in Pigeons.**—OTTO NIESCHULZ (*Archiv. Protistenkunde*, 1921, 44, 71-82, 1 pl., 3 figs.). A description of *Eimeria pfeifferi* Labbé, which infects pigeons and may be the same as *E. tenella* (Raillet and Lucet) in fowls. The parasites are most abundant in the mucous membrane of the intestine 50-70 cm. behind the stomach. The author deals with the schizogony, the development of the microgametes, the development of the macrogametes, the fertilization, and the oöcysts. J. A. T.

**New Gregarines.**—R. POISSON (*Comptes Rendus Soc. Biol.*, 1921, 84, 73-5). In the intestine of the fresh-water amphipod *Echinogammarus berilloni* there was a new species of *Cephaloidophora*, probably the first of this genus in a fresh-water crustacean. For a Gregarine in the food-canal of the sandhopper *Orchestia littorea* the name *Frenzelina mercieri* sp. n. was suggested. This name is pre-occupied, and a reference to the genus *Uradiophora* is proposed. J. A. T.

**Giardia enterica in Man.**—CHARLES E. SIMON (*Amer. Journ. Hygiene*, 1921, 1, 440-91, 3 pls.). A description of the trophozoite of this remarkable flagellate and of the encysted stage. The shape is pyriform, the dorsal surface arched, the ventral surface with a large cytostome. The nuclei are two, dorsal to the cytostome. They are elliptical in the resting stage, each with a karyosome, whence a fine linin fibril leads to a chromatin mass at the anterior nuclear pole which probably represents a centrosome. From each centrosome a rhizoplast curves slightly forward and inward to a blepharoplast granule. The flagella are in four pairs. The caudal flagella pursue a straight though convergent course from the blepharoplasts to two basal granules at the tip of the somewhat bifurcated tail. Their intra-cytoplasmic portions are the axostyles. The ventral flagella originate from two basal "rods" apparently attached to the axostyles. A little posterior to their origin lies a club-shaped "parabasal body." J. A. T.

## BOTANY.

(Under the direction of A. B. RENDLE, M.A., D.Sc., F.R.S., F.L.S.)

## GENERAL,

Including the Anatomy and Physiology of Seed Plants.

## Cytology,

Including Cell-Contents.

**Chromosomes and their Connexion with Heteroploid Varieties of Hyacinthus.**—W. E. DE MOL (*Arch. Neerland. Sc. Ex. et Natur. Haarlem*, 1921, 43B, 18–117, 13 pls.). An account of an investigation as to the nature of the chromosomes of the numerous cultivated varieties of *H. orientalis*. The author sought to ascertain (*a*) if all the individuals which are looked upon as belonging to the same variety contain a corresponding number of chromosomes; (*b*) if when a new variety has arisen at the expense of an old one by gemmary variation, it is possible to discover any divergence in the number or form of the chromosomes; (*c*) if the cells of the Dutch varieties contain a variable number of chromosomes, and if these chromosomes show any variation in form or dimension. Both the present and previous investigations appear to show that there is such variation in the number of chromosomes, and that the size of the nucleus and cells, and hence of the whole plant, is related to this variation. The cause of the variation seems to be physiological rather than cytological, although there is no evidence to prove that such artificial methods as wounding exert any appreciable influence in bringing about the necessary conditions. In the second series of experiments with gemmary variations it was not possible to show that there is any variation in the number, structure or form of the chromosomes; but it seems probable that intimate alterations do occur both in the form and structure, although they have escaped observation owing to the minuteness of their detail. In 19 varieties of Dutch hyacinths the number of normal diploid chromosomes was 16, 4 long, 4 medium and 4 short. In 14 heteroploid varieties the number varied from 19 to 30, but in this case also there were three different lengths; the forms and dimensions corresponded with those of the varieties having 16 chromosomes. The heteroploid varieties must have arisen as the result of fertilization and not by vegetative multiplication. A close examination of several varieties revealed no distinction between the chromosomes of the two parents. A new and exact method of measuring showed that in every case the sum of the lengths of a short and a medium-sized chromosome is equal to the length of the long chromosome. This fact taken in conjunction with other observations makes it probable that the shorter chromosomes arise by transverse division of the long ones. If this is correct the number is reduced to 12 in *H. orientalis*, and to 6 in *H. romanus* and

*Bellevallia Webbiana*, and we should thus have clear examples of a certain number of chromosomes of different forms resulting from transverse division and belonging to the series 2, 4, 8, 16, 32, . . . and to a certain number of similar chromosomes belonging to the series, 3, 6, 12, 24, . . . The author believes that the artificial selection of hyacinth-cultivators is tending to produce results similar to those brought about by natural selection—viz. the disappearance of races with 16 chromosomes and the exclusive preservation of the large and strong races with a greater number of chromosomes.

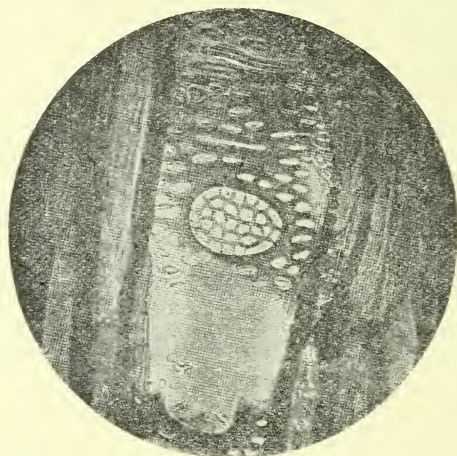
The paper is followed by a review of the literature (pp. 118-43) dealing with previous observations on the cytology of *Hyacinthus orientalis*, which has proved a good subject for study.

S. GREVES.

### Structure and Development.

#### Vegetative.

**Vessels of the Gnetalean Type in Angiosperms.**—R. C. MAC-DUFFIE (*Bot. Gaz.*, 1921, **71**, 438-45, 4 pls.). An account of the vessels of a few woody Angiosperms and also of herbaceous and climbing plants belonging to the Geraniales, the Rosaceæ and the Ranunculaceæ, compared with the vessels of *Ephedra* and *Gnetum*. It is shown that



Radial section of *Ephedra*- or *Gnetum*-like vessel  
perforation in *Pelargonium* sp.  $\times 400$ .

in the groups examined and in numerous other Angiosperms the vessels have typical scalariform perforations side by side with the bordered perforations regarded as characteristic of the Gnetales. There appears to be no foundation for recent statements that the vessels of the Gnetales and the Angiosperms have different and distinct modes of origin.

S. G.

**Annual Rings of Growth in Carboniferous Wood.**—W. GOLDRING (*Bot. Gaz.*, 1921, **72**, 326–30, 1 pl.). An account of the annual rings of growth in species of *Cordaites* of the Carboniferous period. A specimen of *C. recentium* lately found in Oklahoma Forest (which is practically in the same latitude as the Triassic forests) shows distinct annual rings. So far as is known this is the most southern occurrence of Carboniferous wood with annual rings of growth which has been noted. According to Jeffrey such rings indicate a marked variation in the annual temperature, so that this variation must have existed towards the end of the Carboniferous period. The rings are very distinct, and in transverse section vary from 3 to 8 mm. in width. On the weathered surface of the trunk they are equally distinct, and vary from 3 to 7.5 mm. in width. The round bordered pits in a single row on the radial walls of the tracheids distinguish *C. recentium* from *C. materialium*. The rays are numerous, very long, usually uniseriate, never entirely biseriate, and are composed of 2 to 47 cells. *C. recentium* resembles *Dadoxylon antiquum* in having a single row of bordered pits, but differs from it in the practically uniseriate rays. S. G.

**Diameter-growth in Box-Elder and Blue Spruce.**—C. F. KORSTIAN (*Bot. Gaz.*, 1921, **71**, 454–61, 1 fig.). An account of experiments carried out with MacDougal's dendrograph for recording the changes in the size of tree-trunks due to growth and other causes. The first experiment was carried out during April and May with *Acer Negundo*. The first few days were cold and stormy and the tree remained quiescent, with alternate contraction and enlargement of its diameter. Slight growth then began, but ceased during four windy days. The leaves had reached about half their natural size before the main period of growth began. When there was little difference between the day and night temperature there was little change in diameter, but when the nights were cold there was considerable difference in diameter. The second experiment was made with *Picea Parryana* soon after growth had begun. This growth continued for a little over five weeks, except for two rest periods of two days each. Here again temperature was an important factor, since a marked diminution caused decrease or cessation of growth. It was also shown that growth does not begin in deciduous hardwood trees at the same period as in evergreen conifers; in the latter it may be simultaneous with the bursting of the buds, while in the former it may be delayed until the young leaves are large enough to manufacture their own food. The dendrograph will probably prove of much use to foresters in determining the factors most influential in the growth of trees. S. G.

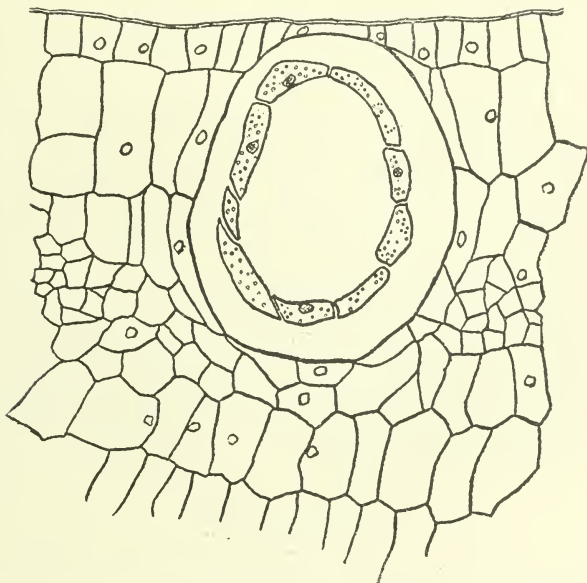
**Growth-rings in Monocotyledons.**—C. J. CHAMBERLAIN (*Bot. Gaz.*, 1921, **72**, 293–304, 16 figs.). An account of the discovery of growth-rings in *Aloe ferox*. This species, which is a true xerophyte, was found near Grahamstown in South Africa. Its stem was 3 metres high and 15 cm. in diameter. In transverse section the zone of secondary xylem was 2 cm. across and the cortex 4 mm.; the central region of primary tissues was nearly 10 cm. across; and the whole section had the appearance of a large pith surrounded by a narrow band of

wood and a scanty cortex. "The cambium which gives rise to the secondary bundles, the secondary cortex and part of the primary cortex between these two zones of secondary growth, are also visible to the naked eye." The primary bundles are of two types; one type is normal, but in the other type the phloem becomes disorganized and almost disappears; the tracheids and vessels become clogged; the cells surrounding the xylem exhibit vigorous meristematic activity, which continues until eight rows of cells have been formed and then ceases. The secondary tissues arise from cambium of pericyclic origin; the bundles have scanty phloem, and companion-cells are rare, but there is no degeneration of tissues or clogging of the tracheids; the surrounding cells show no meristematic activity. There is no cambium between the xylem and phloem such as is found in the primary bundles of many monocotyledons. The xylem cells are only slightly thickened, but are extremely hard. The growth-rings form the most striking part of the stem; both their origin and irregularities appear to be due to climatic conditions. Similar, but less distinct, rings are found in *A. pleuridens*. The writer suggests that the previous failure to find growth-rings in woody monocotyledons may be due to the artificial conditions under which the plants examined have been grown. S. G.

**Oil-ducts in *Eucalyptus* and *Angophora*.**—M. B. WELCH (*Proc. Linn. Soc. New South Wales*, 1921, 46, 475–86, 2 pls., 7 figs.). An account of the discovery of oil-ducts in certain species of *Eucalyptus* and *Angophora*. The details were studied in *E. corymbosa*, and it was found that the leaves and stems contain oil-ducts which are formed by the union of short secretory cavities. They are not continuous, and there is no direct connexion between them and the glands in the leaves, petioles or stems, but they correspond in size and formation, and they appear to secrete oil of a similar nature. They vary in diameter from 0.03 to 3 mm., and in length from 1 to 100 mm., and apparently act as storage-reservoirs. They have not yet been found in the roots nor in the lower parts of the stems of seedlings. The discovery of these ducts in the *Corymbosæ* class of *Eucalyptus* and in *Angophora* is important from an evolutionary standpoint, and confirms the theory put forward by Baker and Smith as to the common ancestry of these two genera. It seems probable that the species examined represent the oldest members of the genus, and that later types have lost these structures during the evolution of isobilateral leaves and a more oblique leaf-venation. S. G.

***Eucalyptus* Oil-glands.**—M. B. WELCH (*Journ. and Proc. Roy. Soc. New South Wales*, 1920, 54, 208–17, 4 pls., 1 fig.). An account of the structure and contents of the oil-glands of *Eucalyptus*. These glands occur in almost every species, but they vary in number, reaching a maximum in such types as *E. polybractea* and *E. costata*, and a minimum in *E. terminalis*. They are found in the leaves, petioles, young stems, calyx, operculum, and even in the fruits; they rarely occur in the bark, but *E. Bridgesiana* and *E. Macarthuri* are exceptions in this respect. It is possible to make a rough classification of certain differences in arrangement of these glands which is characteristic of different species;

thus in *E. hæmostoma*, *E. goniocalyx*, *E. phlebophylla* and *E. Moorei* the glands are flattened at right angles to the leaf-surface, and are confined to the palisade-parenchyma. In *E. intermedia* and *E. corymbosa* they are in the spongy mesophyll, and are narrowed towards the epidermis. In *E. piperita*, *E. aggregata*, *E. hemiphora* and *E. Smithii* the glands extend right across the leaf. In *E. robusta* and *E. resinifera* they are large and directed towards the upper surface; while in *E. maculata*, *E. citriodora* and *E. siderophloia* they are small and directed equally towards both surfaces. Deep-seated glands are characteristic of the petioles. The glands are round, ovate and elliptical in shape, the most



Highly magnified median section of an oil-gland in an intermediate stage of development. The separation of the interior cell-mass (in section) from the wall of the cavity is quite pronounced. An extremely thin lid-cell is seen at the top of the gland. The groups of small cells on either side of the gland indicate vascular bundles. *E. Smithii* Baker.  $\times 400$ .

common form being ovate with the apex towards the upper or lower surface. The formation of oil is the result of alteration of the cell-contents by a schizolysigenous process. The "lid-cells" differ from those of the glands of the Rutaceæ in their lack of definition; it is often difficult to decide as to which are true epidermal cells and which are the "lid-cells." The oil is not always in the form of droplets, but may be more or less granular and lining the cavity or contracted to one side; in the first place it is analogous to a chemical precipitate in the presence of a protein body which acts as a colloid and prevents the formation of drops; finally, it forms an emulsion, which is diffused throughout the secretory cavity.

S. G.

**Xerophytic Leaves of *Pertya phylicoides*.**—J. BRIQUET (*Compt. Rend. Sc. Soc. Phys. et d'Hist. Natur. Geneva*, 1920, **37**, 15–19). A description of the leaves of a new species of *Pertya* (Compositæ) found on the limestone mountains of Yunnan. These leaves are linear, stiff, cylindrical, and sessile; they are about 5 mm. long and 1 mm. broad, and are protected when young by short, oval scales. The inner surface of the scales is velvety, while the outer surface is covered with long, straight, unicellular or multicellular hairs, with thick, very oblique cell-walls traversed by simple connecting passages; these hairs form thick tufts from which the leaves emerge. The leaves are coiled so as to form a distinct inner chamber which communicates with the air by means of an elliptical slit. The external epidermis is formed of cells with exceptionally thick outer walls, much reduced cavities, and internal walls of cellulose slightly thickened and penetrated by numerous canals; the external cuticle has a thick outer layer penetrated by canals, and an internal, cuticularized region through which the canals do not penetrate. The internal epidermis which lines the leaf-chamber is of normal type, with numerous small stomata, and covered with a fine cuticle; there is no trace of the thickening found in the external epidermis. The chamber itself is lined with long thin hairs directed towards the base of the leaf; the structure of these hairs resembles that of the scale-hairs. The mesophyll is normal, but has unusually large chloroplasts, and the vascular bundles are poorly developed. The author believes that the canals of the external epidermis are a device for facilitating the passage of food-material to this region during the time when, having emerged from the protective scales, the leaves require a rapidly-formed protective covering to defend them from the intense sunshine and dryness to which they are exposed. This is the first recorded instance of a xerophytic type of leaf in this genus. S. G.

### Physiology.

**Reserve Material in Pollen-grains.**—HELEN BODMER (*Vierteljahrssch. Naturfor. Gesellsch. Zurich*, 1921, **66**, 339–46). An account of investigations as to the nature of the food-reserves in anemophilous pollen, with special reference to *Populus tremula* and *Fraxinus excelsior*. It is found that the time of dehiscence does not always correspond with a similar stage in the formation of the food-reserve. In *Fraxinus* the transformation of starch into fat goes on equally well in the moist anther and in the dry air subsequent to dehiscence, and the pollen-grain germinates under suitable conditions of moisture without regard to the presence or absence of starch. The fat-reserve of the pollen of *Luzula campestris* and *Juncus articulatus* gives rise to a longer pollen-tube than does the starch-reserve of *Plantago lanceolata* and *Rumex acetosa*. Newly opened flowers of starved plants of *Plantago lanceolata* and of various species of Gramineæ shed pollen, at the end of the first day, in which the fat predominates in quantity over the starch; the same kind of pollen is shed by *Rumex scutatus*, *Carex montana* and *Schænoplectus lacustris* in two to three days. After a longer period of starvation the pollen shed is poor in food-reserves and has large vacuoles. In

*Cannabis sativa* the normal pollen contains little fat or starch, and is highly vacuolate. Thus, it seems that the quantity of food-reserve is of greater importance than the quality. Experiments with *Plantago lanceolata* and other species show that germinating pollen-grains depend upon an external nourishing substratum for their growth. When pollen was germinated in a 5 p.c. glucose solution the tubes were longer and the absorption of starch was more complete than when germination took place in pure water. Under natural conditions the stigma is probably the source of this external supply of food-material. The water-content of the dry pollen of anemophilous species is very small, so that the materials stored in the pollen-grains apparently serve the purpose of maintaining a high osmotic pressure; in *Juncus*, *Secale* and *Plantago* this pressure attains a strength of 3 to 4 G.M. NaCl. S. G.

#### General.

**New Theory of Mermecophily.**—R. CHODAT and LUIS CARISSO (*Compt. Rend. Sc. Soc. Phys. et d'Hist. Natur. Geneva*, 1920, **37**, 9–12). An account of the ant-chambers found in several South American species of *Cordia* and in *Acacia Cavenia*. In *Cordia* these chambers are the result, in the first instance, of a wound made by one of the Hymenoptera, allied to the genus *Eurytoma*. The insect pierces the plant and deposits one or more of its eggs in the opening. The larvæ hatch in the cortex, and cause an irritating stimulus, which is followed by the appearance of a perimedullary meristem; this forms a centrifugal ring of medullary cork, which is gradually eliminated, and centripetal phelloderm, which ultimately hardens and lines the cavity in which the larvæ develop. In *Acacia* it is possible to follow step by step the growth of the cavity in the stipules until the time when the fully grown insect makes its exit by a hole in the thorn. Thus it appears that the abnormal growth in both genera is a kind of gall which the ants afterwards adapt for their own purposes. Moreover, it is no longer possible to admit the theory that these ants are a protection against leaf-cutting ants, since within these cavities typical “ant-gardens” are found, made from portions of floral and vegetative organs torn by them from the host-plants. S. G.

**Acarodermatia in the Clethraceæ.**—J. BRIQUET (*Compt. Rend. Sc. Soc. Phys. et d'Hist. Natur. Geneva*, 1920, **37**, 12–15). An account of acarodermatia on the leaves of *Clethra barbinervis*. When young the leaves are covered with two kinds of hairs—i.e. with simple, stiff unicellular hairs which are firmly embedded in the epidermis and attain a length of 0.4 mm., and branched, stellate hairs at the bases of which are 3 to 6 trichomes grouped together to form a solid mass. The adult leaves are slightly hairy, the upper surface being almost smooth; on the lower surface both kinds of hairs occur here and there in patches, but at the points where the median nerve gives off its branches, there are dense tufts of the stellate hairs, which serve as acarodermatia. The hairs forming each cluster are closely packed together, and the acari find an entrance between the trichomes. The dermatia are of the simple lophic (Lundström) type. There is at present no evidence to show what mutual benefit results from the symbiosis here recorded. S. G.

## CRYPTOGAMS.

## Pteridophyta.

**Vascular Anatomy of *Angiopteris evecta*.**—HUGO L. BLOMQUIST (*Bot. Gaz.*, 1922, **73**, 181-99, 4 pls. and figs.). A developmental study, rendered necessary by the marked changes in the anatomical structure that arise from stage to stage of the plant's growth leading up to the very complex structure in the mature *Angiopteris*. The most conspicuous variations are: (1) elimination of endodermis; (2) appearance of commissural and medullary strands of increasing importance in the central region; (3) repeated bifurcation of leaf traces; (4) point of attachment of the commissural strand and point of forking of the leaf trace become more closely situated to the central strand; (5) variation in place of attachment of root steles. Much of this variation tends to the breaking up of the central strand, a fact which points to a polystelic condition so characteristic of the phylogenetically advanced types of the different groups of vascular plants. The absence of cauline procambium and the definite relation between roots and leaves suggest that the vascular tissue of the central region is a sympodium of leaf traces, and most, if not all, of the central strand is of foliar origin. For the relative distribution of leaf traces, roots, commissural bands, etc., reference should be made to the author's own summary.

A. GEPP.

**Some Observations on *Isoetes Drummondii*** A. Br.—T. G. B. OSBORN (*Annals of Bot.*, 1922, **36**, 41-54, figs.). A study of the biological morphology of this plant. (1) *Isoetes Drummondii* is widely distributed in South Australia, growing terrestrially in seasonal swamps during the winter rainfall. In the dry summer it aestivates, in common with the other geophytes of its association. (2) The stock is buried about 2 cm. deep, and during the vegetative season displays only a small rosette of linear leaves above the soil. (3) The stock is trilobed; the projecting portion of each lobe is composed of caps, such caps being the whole of the leaf- and root-bearing portions of the stock developed in previous growing seasons. The abscission of such caps is a result of the regular alternation of growing and resting periods (during which there is great desiccation). (4) As the dry season approaches, the leaves dry up and become detached, leaving their tough bases and sporangia *in situ* upon the stock, wholly buried and invisible. (5) Early in the rainy season following, the hardened bases of the sporophylls are forced above the surface of the soil in a projectile-like mass, carrying with them the sporangia, by the expansion of certain pads of mucilage cells formed at the close of the previous vegetative season on the extreme bases of the sporophylls and from the superficial cells of the leaf-bearing cortex. About the same time the leaves of the new vegetative season begin to appear. (6) The imbricate mass of sporophyll bases breaks up upon the surface of the soil, and the spores are set free by a tearing away of the sporangium wall from its attachment to the sporophyll when sodden. This is due to a difference between the

tension of the inner and outer surfaces of the sporangium wall when saturated, and results in an eversion of the wall. A. G.

**Annularia with Paleostachya Fruit.**—EDA M. ROUND (*Bot. Gaz.*, 1922, **73**, 326–8, fig.). Description of a fossil *Equisetum*-like plant, *Annularia Clarkii*, from the coal shales of Rhode Island, and bearing a fruit of the Paleostachya type—namely, cones borne in the axils of the sterile bracts. This refutes the contention of some writers that the Annulariæ have always been characterized by *Calamostachys* types of fruit. A. G.

**Index Filicum: Supplément Préliminaire pour les années 1913–16.**—CARL CHRISTENSEN (*Copenhagen*, 1917, 60 pp.). This preliminary supplement for 1913–16 is published at the expense of Prince Roland Bonaparte, and contains over 700 species of ferns described during the above years, the number of described species being thereby raised to about 8000—a number which the editor believes to be well below the total of good species really existing. A. G.

### Bryophyta.

**Air Chambers of Reboulia hemisphærica.**—A. W. DUPLER (*Bull. Torrey Bot. Club*, 1921, **48**, 241–52, 22 figs.). As to the nature and origin of these air chambers there has been much difference of opinion. The results of the author's investigation are as follows:—The very elongated air chambers of the thallus extend lengthwise along the midrib region, and from this radiate pinnately toward the margins of the thallus. The air chamber tissue consists essentially of a single series of oblique chambers extending from the surface to the compact tissue, overlapping one another shingle-like, and thus giving the appearance in section of several series of superimposed chambers. The primary chambers are extensively subdivided into partial secondary chambers by plates of cells arising as lateral outgrowths of the primary walls. The air chambers of both thallus and receptacles originate by splitting of cell membranes, the splits arising both internally and superficially, and generally proceeding from both points of origin simultaneously. The later development of the chambers and the secondary partitioning is due largely to growth of the tissues, further splitting apparently playing but a small rôle in the process. A. GEPP.

**Hepaticæ of New Caledonia.**—WM. H. PEARSON (*Journ. Linn. Soc. Bot.*, 1922, **46**, 13–44, 2 pls.). An account of the hepatics collected by R. H. Compton in New Caledonia in 1914, comprising a list of sixty-two species, twenty-nine of which are new to science. Of special interest is *Chiloscyphus Comptonii*, which has in it the makings of a separate genus; the leaves are provided with a large tooth and a rounded auricle on the postical (upper) margin, and the underleaf bears two such auricles, one at each lateral extremity; further the perianth is adorned with half a score of longitudinal crest-like alae. The plant is allied to *C. cymbaliferus*, which itself is an outstanding member of the

genus. Several other species are of interest, as might be expected from a tropical island with such a notable general flora and with such a geographical position. A. G.

**Southbya nigrella** (De Not.) Spruce in Britain.—W. E. NICHOLSON (*Journ. of Bot.*, 1922, **60**, 67-9). A description of this hepatic discovered for the first time in Britain by the author in November, 1921, near Portland, Dorset. It occurs in the west of France, but its principal distribution is in the Mediterranean region. The genus *Southbya* was founded in 1849 by Spruce, and contains two species, *S. tophacea* and the present species. The distinguishing characters by which this latter, a calcicolous plant, may be separated from the silicicolous *Alicularia scalaris* are pointed out by the author. A. G.

**Ricciocarpus natans** (L.) Corda, from Africa.—W. H. PEARSON (*Bryologist*, 1921, **24**, 69-70). This widely distributed species, though found in Europe, China, Japan, Australia, New Zealand, United States, Mexico, Brazil, had never been recorded for Africa. The author has now examined specimens from the Belgian Congo and from Port Natal (Krause, 1840). Some notes are given about the characters of the fruit (which occurs in the form *terrestris*), and about the internal structure of the rhizoids. A. G.

**Hepaticæ of Bavaria.**—IGNAZ FAMILLER (*Denkschr. Kgl. Bayr. Bot. Gesellsch. Regensburg*, 1917, **13**, 153-304, figs.). An account of the distribution of the hepatics of Bavaria, with a number of critical notes and figures, and with tables showing the distribution of the species in relation to: (1) the geological strata of the country; (2) altitude; (3) neighbouring countries. A. G.

**Epiphyllous Plants of Certain Regions in Jamaica.**—LOUIS J. PESSIN (*Bull. Torrey Bot. Club*, 1922, **49**, 1-14, 1 pl.). A study of epiphyllous cryptogams (especially hepatics and algæ) from two points of view: (1) their distribution in relation to climatic conditions; (2) their relation (parasitic or otherwise) to the leaves that bear them. The material was studied and collected at altitudes ranging from 3000 to 7400 feet. A table is given which displays in parallel columns the locality, supporting plant, and the epiphyllous algæ, lichens, hepatics, and mosses. The epiphyllous position is attained by the plant: (a) by continued acropetal growth, or (b) by means of spores or gemmæ, or (c) by transported fragments. Abundant epiphyllous growth is encouraged by great humidity, moderate temperature, and calm atmosphere. No apparent penetration of the leaf was found upon histological examination of epiphyll-bearing leaves of *Elaphoglossum latifolium*, *Clusia havetioides*, and *Mangifera indica*. The rhizoids of epiphyllous hepatics are especially adapted for the epiphyllous habit by becoming thickened, by flattening out, and by being pressed into the cuticle of the leaf. It is conceivable that the shade produced by the epiphyll, the accumulation of the organic material, the possible excretion of acids and other substances by its rhizoids may have some physiological effect on the supporting leaf. A careful study of the epiphyllous mode of life may

well bring out some close relations between parasitism and the epiphyllous habit. Parasitism is possibly an advanced, specialized phase of epiphytism.

A. G.

**Researches on the Development of the Leaf of Mosses.**—JACQUES POTTIER (*Ann. Sci. Nat. Bot.*, N° Sér., tom. III., 1921, 1–144, 368 figs., 2 pls.). An elaborate study of the leaf-development of some types of mosses (*Andreæa*, *Mnium*, *Atrichum*, *Dicranum*, *Barbula*, *Funaria*, *Leucobryum*) by means of serial transverse sections, very careful drawings, detailed descriptions, and leaf reconstruction by means of plasticine or modelling wax. The principal results are claimed to be as follows: (1) The leaf of mosses grows by means of an initial cell only at the very beginning of its development. (2) The growing region is transferred from the apex to the base of the leaf. (3) The leaf apex is differentiated very early. (4) Some species of *Andreæa* with costate leaves, such as *A. crassinervia* and *A. angustata*, sometimes have in their leaf an initial cell with two faces. This, added to the observations of Kühn and Berggren, shows that in this archaic genus there is a clear tendency towards the mode of growth found in the higher mosses. (5) The embryogenesis of *Mnium punctatum* proves that the leaf margins are in no way comparable with the nerves. (6) A comparative study of the development of the group of stenocyst cells in various mosses shows that their origin is not always the same. (7) There certainly is a foliar asymmetry in the leaves of *Leucobryum glaucum*, although Lorch denied it, and this is a fresh argument for its generality in the mosses.

A review of the work by W. H. Emig has been published in *Bryologist*, 1921, 24, 78–80, in which some criticisms are offered and certain important omissions from the bibliography and historical summary are made good.

A. G.

**Some New Genera of Mosses.**—H. N. DIXON (*Journ. of Bot.*, 1922, 60, 101–110, 1 pl.). Descriptions and figures of seven new genera and six species. *Nanobryum* (type, *N. Dummeri*), from East and South Africa, shows a vegetative affinity with Dicranellaceæ, but in sporophyte characters resembles *Fissidens*. *Chionoloma* (*C. induratum*), from Birmah, characterized by the white border and the structure of its tough leaves, belongs to the Trichostomeæ, but is sterile. *Beddomiella* (*B. funarioides*), from the Nilghiri Hills, is Pottiaceous. *Oedipodiella* (*O. australis*), from S. Africa, is allied to *Oedipodium*. *Chamæbryum* (*C. pottiioides*), from S. Africa, belongs to Funariaceæ, and is allied to *Costesia* Thér., a recent Chilian addition. *Physcomitrellopsis* (*P. africana*), from Natal, is allied to *Physcomitrella*: (a key to the sixteen genera of Funariaceæ is supplied). *Dimorphoclodon* (*D. bornense*), from Borneo, is allied to *Chætomitrium*, Hookeriaceæ.

A. G.

**West Indian Mosses.**—R. S. WILLIAMS (*Bryologist*, 1921, 24, 65–67, 1 pl.). A list of eleven mosses collected at the Kaieteur Falls in British Guiana, and eighteen on the island of Dominica, by Miss E. F. Noel in 1914. New to science is *Macromitrium trinitense*, which is described and figured; it is distinguished by its long slender-

pointed leaves, its elongate cells papillose nearly throughout, and by its small capsule subglobose when dry. Discovered first in Trinidad in 1903, it has now been found to occur also at the Kaieteur Falls. A. G.

**Note on a Moss in Amber.**—H. N. DIXON (*Journ. of Bot.*, 1922, 60, 149–51, fig.) A description of a well-preserved fragment of *Hymnodendron* in a piece of amber from Lower Miocene beds in Upper Burmah. Other pieces of amber contain insects. Judging from the leaf structure, the moss might be *H. Reinwardtii* or *H. arborescens*. Trustworthy records of fossil mosses are scanty—an *Andreaea* from the Devonian in Norway, *Rhynchostegium* and *Glyphomitrium* from the Tertiary in North America, a few from Baltic amber, and from Tertiary deposits in Europe; and a *Mnium* from the Lower Pliocene. A. G.

**New Variety of *Orthodontium gracile* Schwaegr.**—W. WATSON (*Journ. of Bot.*, 1922, 60, 139–41, fig.). An account of a remarkable form of this moss found in September 1920 on the millstone on the borders of Cheshire and Yorkshire at an altitude of 1700 to 1800 feet. It is described as var. *heterocarpa*, and differs from the type in having a shorter, broader, often more or less gibbous capsule, smooth or sulcate, straight or curved; inner peristome teeth minutely punctate; leaves shorter and less flexuose. It is a puzzling plant which might be passed as a *Dicranella*. A. G.

**Mosses of the English Lake District.**—C. H. BINSTAD (*The Vasculum, Newcastle*, 1922, 8, 65–83). An enumeration of all the mosses hitherto recorded for the Lake District, together with their distribution and frequency, and containing a total of 368 species and numerous varieties. Much active collecting was done in Westmorland during last century by G. Stabler and J. M. Barnes. Further research is needed in Cumberland. A. G.

**Moss Exchange Club.**—(*Twenty-seventh Annual Report*, June 1922. Arbroath: T. Buncle, 284–98). Contains lists of Sphagnaceæ, mosses and hepatics collected and contributed by the members of the club, with critical notes on some of the specimens. Corrections are also given of some of the published records for the counties of Worcester, Stafford, Warwick and Hereford. A. G.

**Moss Records from St. Kilda.**—WILLIAM EVANS (*Trans. Bot. Soc. Edinburgh*, 1921, 28, 67–9). A list of thirty-two mosses from the remote island of St. Kilda, the moss-flora of which was almost unknown. There is a tendency to departure from type in several of the species, and fruit is rarely produced. Lying out in the Atlantic, some 40 miles west of Harris, it has a remarkable avi-fauna. A. G.

**Sphagnum as a Surgical Dressing.**—JOHN W. HOTSON (*North-west Division of the American Red Cross*, 1918, 31 pp. 18 figs.). An account of the structure of Sphagnum, its distribution in America, the species best suited for dressings, their remarkable absorbency (up to twenty times their dry weight), the work of the British organizations, the movement in America, the proper way to collect and sort the material, and the improved American dressing with non-absorbent backs. A. G.

**Sphagnum from Bog to Bandage.**—J. W. HOTSON (*Publications Puget Sound Biological Station*, 1919, 2, 211–47, 18 figs.). Detailed instructions for the collection, storing, baling, sorting and drying of Sphagnum. Description of the equipment of a Sphagnum workroom, and of the most approved method of apportioning the work. Minute and precise instructions for making Sphagnum dressings and packing them for hospital use. The dressings were sterilized at the military hospitals by steam heat prior to surgical employment. A bibliography is appended. A. G.

**Sphagnum used as a Surgical Dressing in Germany during the World War.**—J. W. HOTSON (*Bryologist*, 1921, 24, 74–8, pl. and figs.; 89–96, fig.). The value of the Sphagnum dressing is mainly due to its power of absorbing great quantities of fluid. The text-figures supplied show the remarkable porous structure of the plant. The differences of preparation of the dressings for the British and the American armies have already been described by the author; and now he gives an account of the German methods. As long ago as 1882 Neuber, of Kiel, reported on the remarkable and rapid cure of a severe lacerated wound which had been roughly bound up with peat. The value of peat-dressing was at once investigated. During the war, when deprived of cotton by the blockade, the Germans made great use of Sphagnum for dressings—and also employed other mosses, sawdust, wood pulp, hay, straw and even dried algæ. They took less trouble than the British and Americans to clean the Sphagnum, being content to remove hard and sharp particles, twigs, pine needles, etc. They then washed and dried the material. Dressings or pads are composed either of loose material or of heavily compressed cakes, and are made up into such sizes as are required. In Germany the commonest dressing was a pad of loose moss in a muslin bag; another kind of pad was more firmly packed and was moulded in a frame. Very large pads were quilted. For the hard pasteboard compresses, carefully picked and pulverized material was solidified under hydraulic pressure; after being cut to required sizes, the pieces were wrapped in muslin and sterilized with steam heat. They were either damped and used as outer dressings, or, if specially hardened, were used as splints. An account is added of the method employed at Edinburgh for making compressed dressings. There the material was all passed through a bath of corrosive sublimate and dried in trays in a hot room. It was then weighed out and carefully packed into muslin in wooden moulds, the packets being placed in piles of ten under hydraulic pressure of 160 tons. The cakes were cut down and trimmed to size and sewn up in loose muslin covers. Among the advantages claimed for Sphagnum dressings by the Germans are the high absorptive power, the coolness, the cleanness and long-lasting properties, cheapness and abundance. A. G.

### **Thallophyta.**

#### **Algæ.**

**Free-living Unarmoured Dinoflagellata.**—C. A. KOFOID and OLIVE SWEZY (*Memoirs Univ. California*, 1921, 5, pp. viii + 562, 12 col. pls.,

388 text-figs.). A large and important monograph treating of the morphology, physiology, life cycles, development, etc., of this group, and giving a detailed systematic classification. The Peridinales are a monophyletic group derived from a cryptomonad ancestry. The new genus *Protodinifer* is the simplest form known to us. Starting from it, a line of development might lead to *Haplodinium*, *Ecuvella*, *Protocentrum*; another such line might lead to the simpler Gymnodiniaceæ, and branch on the one hand to the higher unarmoured forms (including *Pouchetia* and *Erythropsis*) and on the other to the thecate forms (*Ceratium*). Descriptions of 16 genera and 223 species are given. The new genera are *Protodinifer*, *Gyrodinium*, *Torodinium*, *Pavillardia*, *Protopsis*, *Nematodinium*, *Proterythropsis*.  
A. GEPP.

**New Kinetic Mechanism. Syndinial Mitosis in the Plasmodial Parasitic Peridiniæ.**—EDOUARD CHATTON (*Comptes Rendus Acad. Sci. Paris*, 1921, **173**, 859–62, fig.; see also *Bot. Gaz.*, 1922, **73**, 330). An account of observations made on species of *Syndinium*, which live parasitically in the body cavity of Copepods. Their nucleus contains but a small number of chromosomes, though previously described as ten, ranged like the ribs of an umbrella round one of the poles. In reality they are five sharply bent chromosomes, with the apices of the sharp angles converging at one pole. Each becomes cloven longitudinally. Five of the daughter-chromosomes remain grouped at the original pole; the angles of the remaining five become centred about a new pole which gradually moves away from the original pole. In some species the cleavage is completed at once; in others the daughter-chromosomes remain united at their tips, and form for a while a bipolar spindle-shaped structure. No true achromatic spindle was observed. Ordinarily no resting stage occurs. The author gives this mitosis a special name, "syndinial," and is of opinion that a similar form of nuclear division will be found in the free Peridiniæ. A. G.

**Classification of Some Colonial Chlamydomonads.**—W. BERNARD CROW (*New Phytologist*, 1918, **17**, 3–8, figs.). The name Chlamydomonadales is preferable to that of Volvocales for the order here under discussion. The distinctive characters of the families Sphærellaceæ and Chlamydomonadaceæ are displayed in parallel columns. The systematic position of *Volvox* is shown to be with Sphærellaceæ rather than with the latter family; it has arisen independently of the other known colonial Chlamydomonadales. *Gonium*, *Pandorina* and *Eudorina* are colonial members of the true Chlamydomonadaceæ. Reproductive colonies of *Pandorina* possessing one to four sterile cells have been observed.  
A. G.

**Phylogeny of the Genus Brachiomonas.**—TRACY E. HAZEN (*Bull. Torrey Bot. Club*, 1922, **49**, 75–92, 2 pls., and figs.). *Brachiomonas* was established in 1898 by Bohlin with two species from Stockholm. *B. submarina*, the type, had been previously discovered by Dangeard and by Lagerheim, but not described. It belongs to the *Chlamydomonas* group, and has a distribution on the coasts of Norway, England, France, and Corsica. It was found by the author in 1907 near New York, and not

again at that locality until 1919. It is of rather sporadic appearance, and sometimes puzzling in its varieties of form. The author describes a new form, f. *obtusa*, from Pelham Bay, New York, and discusses its cytological structure and reproduction. Being marine, it lacks the two pulsating vacuoles found in fresh-water *Chlamydomonas*. He also describes and discusses *Brachiomonas simplex*, a new species found by him at Aalesund in Norway, where also he secured the rare *Chlamydomonas caudata* Wille, which also he discusses. In writing of the phylogeny of these genera, he objects to the intermediate position allotted to *Lobomonas* by Wille and by West, and regards that genus as a special offshoot from the *Chlamydomonas* line. A. G.

**New British and American Species of Lobomonas: A Study in Morphogenesis of Motile Algæ.**—TRACY E. HAZEN (*Bull. Torrey Bot. Club*, 1922, **49**, 123–40, 2 pls.). *Lobomonas* is a genus nearly allied to *Chlamydomonas*; two species of it are known; and two new species are now described and figured, *L. pentagonia* and *L. rostrata*—the former from Ham Common, Surrey, and the latter from New Jersey and Vermont. The second part of the paper is concerned with the morphogenesis of motile algæ. After a survey of the work and views of Harper, Perty, McClendon, D'Arcy Thompson, Jennings and others, upon amœboid movement, Hazen expresses his opinion that the lobes and excrescences of *Lobomonas*, *Brachiomonas* and *Pteromonas* are the expression of the same non-homogeneous organization of the protoplast as is characteristic of *Amœba*. A. G.

**Notes from the Woods Hole Laboratory. 1921.**—I. F. LEWIS and W. R. TAYLOR (*Rhodora*, 1921, **23**, 249–56, 1 pl. and figs.). A series of notes on interesting algæ. A *Platymonas* was found near New Bedford Harbour, U.S.A., which proved to be identical with *Carteria subcordiformis* Wille. It will grow in fresh, brackish or sea water, and prefers the presence of a little organic pollution. Tracy E. Hazen has collected it in seven localities, has studied it carefully, and definitely transfers it to *Platymonas*. It is suggested that *Platymonas* is the free motile stage of *Prasinocladus* (the *Palmella* stage). Other notes treat of *Asterococcus superbis*, *Anabæna spiroides*, *Bryopsis hypnoides* (with abundance of male and female gametes), *Ectocarpus Mitchellæ* Harv. var. *parva*, a new variety found on the carapace of a turtle. All these are figured. A. G.

**Researches on the Chemical Constitution of the Cell Wall of the Cyanophyceæ.**—EVA MAMELI (*Atti Ist. Bot. Univ. Pavia*, 1920, **17**, 257–64). Some hundred species belonging to 34 genera were examined, and yielded the following results:—1. Cellulose is present in the cell wall of all the Cyanophyceæ, thus bringing them into uniformity with the chemical behaviour of the dermatoplasm of the generality of vegetal cells. 2. The cellulose is generally accompanied by a pectic substance. 3. Search for chitin gave negative results. 4. The products of hydrolysis of the cellulose of the Cyanophyceæ are pentosans and galactans. Thus the cell wall of the Schizophyceæ is in general of a celluloso-pectic nature. Our knowledge of the cell wall of other algæ

is far from precise. Cellulose with a little pectin in the Peridiniæ; pectin without cellulose in the Diatomaceæ; cellulose as a general rule in the Chlorophyceæ (with the exception of the Siphonææ, where cellulose is disputed and callose and pectin affirmed); both cellulose and pectin in the Phaeophyceæ and in the Floridææ. A. G.

**Critical Study of certain Unicellular Cyanophyceæ from the Point of View of their Evolution.**—W. B. CROW (*New Phytologist*, 1922, 21, 81–102, fig.). An analysis of the characters of certain unicellular Chroococcaceæ with a view to ascertaining their importance in the evolution of the group, and hence in helping to establish a satisfactory system of classification. The work proceeds under the following headings: Cell-form, cell-size, internal structure of cell, mucilage, pigment, planes of cell-division. Some of these characters, such as orientation of planes of division, cell-form, cell-size, have long been in use as systematic distinctions. The presence of pigments, pseudovacuoles, and stratified membranes may also be of importance. Further, the differentiation of the protoplasm, and particularly the distribution of the pigment, are very significant, though not yet appreciated in schemes of classification. On the other hand, the character of the stratum or colony is of but slight morphological significance, and should not be too much trusted by systematists. The author holds that the most prominent indications of the primitive character of the Chroococcaceæ are the production of several pigments in the plasma; the variability of these pigments in amount and distribution; the unspecialized character of the envelope, and its pectic nature; the variability in the differentiation of the layers of the protoplasm, including the plasma-membrane, so that sometimes the cell may be homogeneous; also the lack of a definite chloroplast and a nucleus. The complete absence of flagella in the Cyanophyceæ is a remarkable feature, which may or may not be a secondary character. A. G.

**Determination of the Optimum of Humidity required by the Oscillariææ.**—HENRI COUPIN (*Comptes Rendus, Paris*, 1922, 174, 822–4). These algæ, when cultivated in a vessel of water, congregate at the edges and raise themselves to nearly 1 cm. on the sides. They do the same in nature. The author seeks to know the reason for this, whether it is due to needs of oxygenation, of light, of osmosis, of degree of humidity, etc. To test the question of humidity he prepared jellies of various strengths of gelose in fresh water and in Knop's medium, and sowed *Oscillaria* on the surface. The alga succeeded best on jellies containing 1 p.c. of gelose, but less well or not at all on stronger and on more watery jellies. There is thus an optimum of humidity; and it may be that in nature, when climbing the walls or margins of pools, they are seeking the limit of relative dryness that is compatible with their existence. Water they need, but in moderation. A. G.

**Heleoplankton of Three Berkshire Pools.**—B. MILLARD GRIFFITHS (*Journ. Linn. Soc. Bot.*, 1922, 46, 1–11, 1 pl.). The three pools are near Reading, and have been artificially dammed up in stream valleys. A total of 65 algæ was obtained from them, and their distribution is

discussed. Among the ten species of special interest is a novelty—*Peridinium Suttoni*—which is described and figured. Figures of six other species are given. A. G.

**Fresh-water Algæ of New Caledonia.**—NELLIE CARTER (*Journ. Linn. Soc. Bot.*, 1922, **46**, 47–68, 1 pl. and figs.). Little was known previously of the fresh-water algæ of New Caledonia. The present collection, made in 1914 by R. H. Compton, has yielded about 170 species. It is rich in diatoms (60 species), and fairly rich in filamentous Chlorophyceæ, which are plants of the running streams. The Cyanophyceæ, subaerial plants, proved very interesting, supplying a new genus, *Rosaria*, and three new species. Desmidiæ, which require still water and permanent boggy conditions, were not abundant; they principally consist of species of *Closterium* and *Cosmarium*. *Rosaria ramosa* is a moniliform uniseriate branched filament related probably to *Hapalosiphon*, but is devoid of heterocysts and without a sheath. It grew in association with *Mastigocoleus obtusus*, which also is destitute of heterocysts. *Seytonema Hieronymi*, described from Samoa by Schmidle, is so closely associated with a fungus as to form a lichenoid compound. A. G.

**Contributions to the Diatom-Flora of Bavaria.**—ANTON MAYER (*Denkschr. Kgl. Bayr. Bot. Gesellsch. Regensburg*, 1917, **13**, 1–152, 12 pls. and figs.). This report contains lists of the diatoms of the Fichtelgebirge, the Bayrische Walde, Dillingen on the Danube, a fish-pond at Kondrau, and other sources; also critical notes, numerous figures and distribution-tables, constituting several hundreds of records. A. G.

**Moisture Relations of Terrestrial Algæ. I. Some General Observations and Experiments.**—F. E. FRITSCH (*Annals of Bot.*, 1922, **36**, 1–20, 2 figs.). An account of experiments and observations made in field and laboratory on *Pleurococcus Naegeli* Chod., the *Hormidium* stage of *Prasiola crispa*, and *Zygnema ericetorum*. The author's conclusions are as follows:—1. The protoplasts of the terrestrial algæ examined have either no large vacuoles (*Pleurococcus* and *Hormidium*) or but few of them (*Zygnema*), the sap being dispersed through the cytoplasm. 2. In drought much of this sap is retained, more so in *Hormidium* and *Pleurococcus* than in *Zygnema*. 3. In drought contraction occurs, but the protoplast remains closely invested by the cell-wall (*Pleurococcus* and *Hormidium*), or in contact with it at certain points (*Zygnema*). 4. Hence moisture imbibed into the walls from the atmosphere will reach the protoplast, especially in *Pleurococcus* and *Hormidium*. 5. *Pleurococcus* does not appreciably contract on drying, but *Hormidium* evidently contracts and shows a longitudinal folding of the walls along special lines of weakness. In *Zygnema* the amount of contraction is variable. The capacity for absorbing moisture is least in *Pleurococcus* and greatest in *Hormidium*, but smaller than in aquatic algæ. 6. These terrestrial algæ therefore (especially *Pleurococcus*) require but little moisture to replace that lost in desiccation. 7. Appreciable amounts can be absorbed when the air is very humid; and probably some growth occurs then. 8. Terrestrial algæ, as compared

with inanimate material, both absorb moisture more rapidly from a humid atmosphere and lose it more slowly in a drying atmosphere. 9. The sap of these terrestrial algae is highly concentrated—so much so after a little evaporation that further loss of moisture is prevented. The rate of drying of the different forms varies much, the *Hormidium* stage of *Prasiola* being slowest. Thus terrestrial algae are well equipped to face vicissitudes. Actual desiccation does not take place, since the air-dry cells retain a good proportion of moisture. And this retention of moisture is presumably due to the highly concentrated cell-sap; but the absence or paucity of vacuoles may mean that much of the sap is held adsorbed by colloidal constituents within the protoplast. The granules (reserve-bodies) of these algae may be due to the peculiar conditions in the protoplasts as a result of the absence of vacuoles. Possibly too they are part of the mechanism for retaining moisture in the cells.

A. G.

**Fixation of Nitrogen by Green Plants.**—F. B. WANN (*American Journ. of Bot.*, 1921, 8, 1–29, 1 pl. 1 fig.). An account of experiments that show that some Chlorophyceae can utilize nitrogen from the atmosphere. This they do when grown on mineral nutrient agar containing a nitrate and glucose. If the carbohydrate be absent very little atmospheric nitrogen is fixed; and this fixation ceases when organic nitrogen is supplied. The algal fixation of nitrogen compares favourably with that recorded for nitrogen-fixing bacteria.

A. G.

**Method of Healing in some Algal Cells.**—SUSAN P. NICHOLS (*American Journ. of Bot.*, 1922, 9, 18–27, 1 pl.). An account of experiments made in wounding mature cells of certain algae (*Nitella*, *Chara*, *Vaucheria*, *Cladophora*, *Chætomorpha*), and of the results observed. All but one of the species studied are able to heal a wound. The protoplasmic density in some species is very liquid and varies up to a quite viscous condition in other species. No correlation was found to exist between the protoplasmic density and the character of the cell wall. The exuded protoplasm may or may not be miscible with water. If the exuded protoplasm be non-miscible, the film formed over the escaping protoplasm is not comparable with the plasma membrane. The wound-puncture is not closed by a film or membrane, but by an accumulation of the plastids, pyrenoids, and starch granules in the opening. A new plasma membrane grows inward from the old membrane and separates a portion of the protoplasm, filling the puncture from the remainder of the cell. A new wall is gradually formed by this membrane, and the healing is complete.

A. G.

**Reproduction of Vaucheria by Amœboid Zoospores.**—A. DE PUYMALY (*Comptes Rendus*, Paris, 1922, 174, 824–7). In 1879 Stahl (*Bot. Zeit.*, 37, p. 129) announced a remarkable mode of reproduction in *Vaucheria geminata*, in which a large number of amœboid zoospores escape from the mother-cell, creep about for a time, then round themselves off, develop a cell wall, and finally germinate and produce a new individual. This observation had not been followed up. But last February the author found *V. hamata* growing on sand near Bordeaux, which in the greener part of its feltwork showed regularly segmented

filaments, comparable with the plant figured by Kützing (*Tab. Phyc. IV. t. 98*) as *Gongrosira dichotoma* (which Stahl claims as a developmental stage of *V. geminata*). These segments or articulations are potential sporangia; when placed in water, if young they grow out in any direction each as a vegetative filament, but if old they liberate their spore-contents. The mode of sporogenesis, the mechanism of spore-discharge, the morphology of the spores, their amœboid movements, their coming to rest, and their germination after a few days are all described. This mode of reproduction occurs in aerial plants only.

A. G.

**Notes on Charophytes.**—G. R. BULLOCK-WEBSTER (*Journ. of Bot.*, 1922, **60**, 148–9). Records of new British localities for some rare Characeæ. *Tolypella nidifica* and *Chara canescens* have been found in brackish water in Orkney. The former was known from one locality only, Wexford. *C. canescens* is a parthenogenetic species, the male plant never having been detected in this country, and rarely elsewhere. *Nitella batrachosperma*, the smallest of the British Charophytes, grows in deep water, and is probably less rare than it appears to be. *N. spanio-clema*, a recently described species from Ireland, has now been collected in Perthshire.

A. G.

**Charophyta of New Caledonia.**—JAMES GROVES (*Journ. Linn. Soc. Bot.*, 1922, **46**, 69–70, 1 pl.). Four species of *Nitella* and two of *Chara* collected by R. H. Compton in New Caledonia in 1914. *Nitella Comptonii* is new to science, and is described and figured.

A. G.

**Preliminary Notes on the Development of the Carpospores of *Porphyra tenera* Kjellm.**—K. OKAMURA, K. ONDA, and M. HIGASHI (*Bot. Mag. Tokyo*, 1920, **34**, 131–5, 1 pl.). A criticism of Prof. Yendo's paper on the subject (*op. cit.*, 1919, **33**, p. 73). The authors describe their own cultures of *P. tenera* grown in various media. Spores liberated from the margins of fruiting pieces of the alga took at first an amœboid alternation of form, and soon after became roundish. After two to three days many of the spores began to germinate by throwing out a small process, which gradually elongated, and after about nineteen days had developed into a slender, occasionally branched, segmented filament. Sometimes two or three filaments were emitted from one spore. The cell-contents varied according to the nutrition, but the distal end of the filament was always colourless. The authors regard these filaments as rhizoidal, and emitted in order to absorb the necessary nutrition; though they may also have the character of protonema. In one case a sporeling had developed as a branch of a rhizoidal filament. Carpospores of *P. suborbiculata* under culture developed in ten days into young fronds having long colourless root fibres. The form of the sporeling in *P. tenera* differs from that of *P. orbiculata*. As regards the long rhizoidal filaments, which have disappeared in the other plant, and given place to holdfasts, the authors believe that they became atrophied. It appears to depend on the degree of maturity of the carpospores whether they remain in a non-divided or sparingly divided state, or whether they soon develop into young sporelings. The contents of immature and mature carpospores are different. The immature carpo-

spores emit long rhizoidal filaments; the mature ones germinate soon into young fronds, either emitting short rhizoids or not. No case was found of a single cell producing male and female swarming gametes, as described by Prof. Yendo. It is suggested that they bear a strong resemblance to Chytridean parasites.

E. S. GEPP.

**Systematic Position of "Delesseria quercifolia" from California.**—CARL SKOTTSBERG (*University of California Publications, Botany*, 1922, 7, 427-36, 1 pl.). A discussion of the relation of this plant to the true plant as found in the subantarctic region of South America, and a demonstration that, though agreeing with the type in many particulars, the Californian alga is narrower and more entire in outline, and differs in the transverse section of the costa. Summarizing the past history of the Delesseriæ, the author shows that it is desirable to re-establish Kützinger's genus *Phycodrys*, with the European *P. sinuosa* as type. A second species is *P. quercifolia* (Bory) Skotts. from the Magellan region. A third is *P. Setchellii* Skotts., the Californian plant, a diagnosis of which is given. The author has paid much attention to the mode of growth, anatomical structure, position of cystocarps and sori of many species of Delesseriæ, and finds that he can refer every specimen to one or other of two principal types—the *sinuosa* type or the *hypoglossum* type.

A. G.

**Efflorescence of *Rhodymenia palmata*; Presence of a Xylane in the Florideæ.**—C. SAUVAGEAU and G. DENIGÈS (*Comptes Rendus, Paris*, 1922, 174, 791-4). This alga, formerly an article of food, known as "Dulse," does not produce a jelly when boiled. When dried, it gradually becomes covered with a white efflorescence of sweetish taste composed of crystals of potassium chloride and of mannite. But though Icelandic specimens yield mannite, French specimens do not; nor do they yield trehalose (though Kylin found about 15 p.c. in dried Swedish samples). Mrs. Swartz extracted a pentosan from American plants. The present authors also extracted pentosan from French samples, and are able to demonstrate for the first time that it is a xylane; and they predict that this substance will be found in other Florideæ. The process of extraction is a tedious one. The methyl-pentosan, which was also found, is probably the source of the mannite which effloresces after the drying of *Rhodymenia palmata*. Mannite is commonly found in brown algæ.

A. G.

**Additions to Oceanic Algology.**—ANGELO MAZZA (*Notarisia*, 1922, 33, 1-51). A morphological account of some confused and difficult genera of Florideæ. *Leptocladia* has benefited by the researches of W. A. Setchell, who has found it to be referable to Dumontiaceæ and to the vicinity of *Pikea*; and that to the Californian *Leptocladia Binghamiæ* J. Ag. must be referred the obscured *Andersoniella Farlowii* Schmitz, a plant which has been distributed as *Farlowia compressa*. A second species is *L. conferta* Setchell, also from California. The genus *Nitophyllum* has been divided by J. Agardh into four subgenera: *Leptostroma*, *Aglaophyllum* (with eight sections), *Polyneura*, and *Cryptoneura* (with five sections). Mazza discusses the

structure of *N. Curdieanum* Harv. and *N. Durvillei* (Bory) J. Ag. The genus *Botryoglossum* is divided into five sections, and two species are discussed, which possibly belong to *Nitophyllum*. The genera *Phytomophora* and *Schizoneura*, each with one species, are described; and in Bonnemaisoniaceæ, *Ptilonia*, with one species, is discussed.

A. G.

**Phycological Contributions II. to VI.**—WILLIAM ALBERT SETCHELL and NATHANIEL LYON GARDNER (*Univ. California Publications, Bot.*, 1922, **7**, 333–426, pls. 32–49). Descriptions and figures of new species of the following brown algae:—*Myrionema*, *Compsonema*, *Hecatonema*, *Pylaiella*, *Streblonema*, *Ectocarpus*. In *Myrionema* the principal characters are: (1) the monostromatic basal disc, composed of crowded branched filaments radiating from a common centre; (2) erect filaments arising (one each) from the basal disc cells, and either all fertile (with zoosporangia or gametangia) or some sterile; (3) the loculi of the gametangia are uniseriate—8 new species and 13 new forms of this genus are described. *Compsonema* differs in having pluriseriate loculi in its gametangia; 15 new species and 2 forms are described. *Hecatonema* has a distromatic base and gametangia with pluriseriate loculi; 3 new species. *Pylaiella*, 2 new species. *Streblonema*, 12 new species and 1 form. *Ectocarpus*, 14 new species and 5 forms. A new order, Ectocarpales, is defined, and the characters by which it differs from Cutleriales, Sphacelariales, Laminariales, and Dictyosiphonales are briefly indicated.

A. G.

**Efflorescences of Cystoseira.**—C. SAUVAGEAU and G. DENIGÈS (*Comptes Rendus, Paris*, 1921, **173**, 1049–53). Results obtained by microchemical tests from carefully dried specimens of all the species of *Cystoseira* found on the French coast. The efflorescences of these brown algae are potassium chloride and mannite, varying in amount. The KCl presumably comes from the cell sap, and the mannite arises from the transformation of hexosic polysaccharides.

A. G.

**Composition of the Laminariæ.**—P. FREUNDLER, Y. MENAGER and Y. LAURENT (*Comptes Rendus, Paris*, 1921, **173**, 1116–18). While investigating the occurrence of iodine in algae, these authors have previously shown that the amount of iodine varies with the season, the age of the plant, etc. They now show that the iodine is returned to the ocean upon the decay (partial or complete) of the various species of *Laminaria*. For example, *Saccorhiza bulbosa* dies down annually; *Laminaria Cloustoni* sheds its old frond each spring; *L. saccharina* and *L. flexicaulis* decay above. But further than that, the percentage of iodine amounts to 0.7 in spring, 1.0 in summer, 0.55 in autumn, in a given plant—which means a loss of 50 p.c. of the iodine at the end of summer. Similarly there is a great diminution in the stored carbohydrate reserve (laminarin) and in the brown pigment at the end of summer. All three are in their greatest abundance during the season of highest insolation. It seems fair to suppose that the iodine is an essential factor of chlorophyll-assimilation in the Laminariæ; but we do not yet know in what combination the iodine exists in the living plant.

A. G.

## Fungi.

**Method of Cleavage in the Sporangia of Certain Fungi.**—CARL A. SCHWARZE (*Mycologia*, 1922, 14, 143-72, 2 pls., 2 figs.). The writer gives a general sketch of spore formation, etc., in sporangia, describes his methods of work, and then proceeds to the more particular account of different types. In *Olpidiopsis* he gives the different stages, the formation of vacuoles, cleavage by furrows cutting outward from the central vacuole, formation and swelling of spore initials with the appearance of hyaline spaces between, finally contraction and rounding up of the spores. Equally careful examination is made of *Saprolegnia* and *Achlya*, *Sporodinia grandis*, *Mucor racemosus*, *Circinella minor*, *Mucor Mucedo*, *Rhizopus nigricans* and *Pilobolus crystallinus*. The writer lays stress on the various contraction and expansion phases accompanying the formation of spores, and compares the development of the spores with those of some algæ. A. LORRAIN SMITH.

**Phytophthora infestans on Egg-plant in the United States.**—R. J. HASKELL (*Phytopathology*, 1921, 11, 504-5). During the summer of 1915 the writer noticed about six egg-plants in a field closely surrounded by potato plants infected with *Phytophthora infestans*. He observed that the disease had passed to the egg-plants. He does not, however, consider that there need be much fear of the disease, as the egg-plant belongs essentially to warm climates unfavourable to potato culture. A. L. S.

**Chytridiaceous Fungus parasitic on a Marine Alga.**—GEORGE W. MARTIN (*Bot. Gaz.*, 1922, 73, 236-8, 10 figs.). Martin found this fungus on a sterile plant of *Callithamnion* from Barneget Bay, New Jersey. The living fungus could not be studied, but careful descriptions and figures are given as far as they were possible. Several species of *Rhizophidium* are known as parasites of algæ in brackish water. The present species corresponds most nearly with *R. polysiphoniæ*. A. L. S.

**Cytological Fungus Study. II. Research on Some Hemiascæ.**—H. O. JUEL (*Nova Acta Reg. Soc. Sci. Upsal.*, 1921, Ser. IV., 5, No. 5, 41 pp., 4 pl., 4 figs.). The author has examined a number of genera and species, and his results are given in considerable detail. *Endomyces decipiens* has mitotic nuclear division in the vegetative cells. The ascus has a large nucleus which passes through a stage similar to the spirem; there are at least two mitoses, probably representing a reduction division, probably also a third division, and Juel suggests a fusion in the ascus of these eight nuclei to form four spores. *Dipodascus* and *Taphridium* are described and several species of *Taphrina*. In the latter genus the vegetative cells contain typical nuclei which lie in pairs, and doubtless undergo conjugate division. *Taphrina bullata* has several pairs in each cell—the other species only one pair. In the ascus, the plasma collects at the upper end, and three nuclear divisions take place. Juel considers that the group of Hemiascæ is of a primi-

tive type and is nearest to the Phycomycetes. Their "asci" or sporangia rise from the mycelium, whereas in Ascomycetes they derive from Ascogenous hyphæ.

A. L. S.

**Analytic and Descriptive Flora of Tuberoideæ in Europe and North Africa.**—F. BATAILLE (*Bull. Soc. Mycol. France*, 1921, **37**, 155–207). The author begins his paper by a general account of Tuberaceæ, their structure, occurrence, methods of determination, etc. The history and classification follow. A key to the genera is given and the descriptive key for species of each genus. There are two families, Tuberaceæ and Elaphomycetaceæ, the former with eleven genera, the latter with three.

A. L. S.

**Observations on the Perfect Form of the Oak Oidium in Italy.**—B. PEYRONEL (*Le Stazioni sperimentali agrarie italiane*, 1921, **54**, 5–10; see also *Bull. Agric. Intell. Rome*, 1921, **12**, 643–4). The author has found ripe perithecia on oaks in the neighbourhood of Rome. He considers that the formation of these bodies is induced by a sudden fall of temperature after a time of great heat. He has determined the species as *Microsphæra quercina*. The species that appeared sporadically before 1907 on oaks in Portugal is to be regarded as *Microsphæra Alni*.

A. L. S.

**Genus Catinella.**—ELIAS J. DURAND (*Bull. Torrey Bot. Club*, 1922, **49**, 15–21). The genus *Catinella* was formed by Boudier to contain *Peziza olivacea* of Batsch. Durand finds an older name, *C. nigro-olivacea*, for the species which grows on rotten wood in Europe, Asia and America. Full description and synonymy of the plant are given, and a second species is included in the genus, *Catinella elastica* (Patr. and Gail.), which differs in the larger spores.

A. L. S.

**Sclerotinia minor sp. n. injurious to Lettuce, Celery and other Crops in the United States.**—I. C. JAGGER (*Journ. Agric. Research*, 1920, **20**, 331–2, 1 pl.). A similar fungus had been described as causing rot of lettuce in Massachusetts. Recently it has appeared near Philadelphia and in Florida. The effects produced on the host plants are almost identical with those caused by *Sclerotinia Libertiana*: a sudden collapse of the whole plant, which is converted into a soft watery mass. It has been found that the fungus attacks a large number of plants.

A. L. S.

**Myriangium on Pecaw (*Carya illinoensis*).**—L. E. MILES (*Mycologia*, 1922, **14**, 77–80, 1 pl.). The author describes a new species, *Myriangium tuberculans*, which forms tubercles on the living bark of the pecaw. It is found on all varieties of the host tree. It is superficial and causes no real injury, but is somewhat unsightly and mars the appearance of the trees. The asci are formed in locules of the stoma and contain muriform, almost colourless spores.

A. L. S.

**New or Noteworthy Rusts on Carducaceæ.**—H. S. JACKSON (*Mycologia*, 1922, **14**, 104–20). The author is preparing the rust portion of the North American Flora, and as numbers of new species

have been found he has thought it wise to publish them at once. Notes are given on species already known. Most of the new species belong to *Puccinia*, a few belong to *Coleosporium*. A. L. S.

**Susceptibility of Wheat to Bunt.**—O. VON KIRCHNER (*Zeitschr. Pflanzenkr.*, 1916, 26, 17-25). The author has made a series of tests on wheat seedlings, and he comes to the conclusion that immunity rests on the different chemical content of the plant cells. He cites the results on two varieties of wheat extremely like each other, but varying as regards their liability to become diseased. He found that the acid content was perceptibly higher in the more immune of the two.

A. L. S.

**Susceptibility of *Phaseolus vulgaris* and *P. multiflorus* to Rust and other Diseases.**—GEORG LAKON (*Zeitschr. Pflanzenkr.*, 1916, 26, 83-97). These two species of *Phaseolus* are the ones most commonly cultivated for beans. Of *P. vulgaris* there are innumerable varieties, while there are few for *P. multiflorus*. There is also a remarkable difference in susceptibility between the two species. The writer has gathered from his own experiments and from literature that *P. multiflorus* is almost immune not only to rust, but also to other parasitic fungi such as *Gloeosporium Lindemuthianum*, *Uromyces appendiculatus*, etc.

A. L. S.

**Studies of Corn Rust.**—GEORGE F. WEBER (*Phytopathology*, 1922, 12, 89-97, 3 figs.). The writer experimented with *Puccinia Sorghi*, infecting seedlings with the urediniospores. He tested the various temperatures, and found that the optimum for infection was about 18°C. The germ tubes of the spores entered the plants by the stomata, with or without appressoria. The spores did not overwinter in Wisconsin (1919-1920).

A. L. S.

**Experiments in the Infection of *Pinus Strobus* with *Cronartium Ribicola*.**—HARLAN H. YORK and WALTER H. SNELL (*Phytopathology*, 1922, 12, 148-50). The writers inoculated about 500 potted seedlings of *Pinus Strobus* with teleutospores from freshly picked leaves of *Ribes nigrum*. The methods of inoculation are described. The experiments were begun about August 1921. The plants were examined in November of the same year, and already many inoculations had been successful: typical yellow spots were formed on the needles. They reckon that sporidia are developed in five to six hours after the dry teleutospores have been brought into favourable conditions for germination, and that infection may occur within 12½ hours after the sporidia reach the needles of *Pinus Strobus*.

A. L. S.

**Incidence of Loose-Smut in Wheat Varieties.**—F. D. FROMME (*Phytopathology*, 1921, 11, 507-10). The writer noted that a certain variety of wheat was free from loose-smut, *Ustilago Tritici*. He has been testing various varieties, and he finds that three bearded varieties took infection very much in excess of three beardless varieties. Control of the disease may thus be secured by selection or by breeding of immune varieties.

A. L. S.

**Two Important Pine Cone Rusts and their New Cronartial Stages.**—G. G. HEDGCOCK and GLENN GARDINER (*Phytopathology*, 1922, 12, 109–22, 2 pls.). The rust designated *Cæoma strobilina* on cones of *Pinus palustris* has been known for some time. The authors of this paper have satisfactorily proved the further stage as a *Cronartium* wintering on evergreen oaks. The account of inoculation experiments is given, and a record of the localities and hosts where the *Cæoma* and *Cronartium* have been collected. Another relationship determined is that of *Cæoma conigenum*, the *Cronartium* stage of which also develops on species of *Quercus*. A. L. S.

**New Species of the Genus Urocystis.**—FRANÇOIS BUBAK (*Bol. Real. Soc. Esp. Hist. Nat. Madrid*, 1922, 22, 205–7, 2 figs.). This new member of the Ustilaginæ was discovered on the grass *Lolium perenne*, in the neighbourhood of Toledo. It resembles *Urocystis occulta* in that it attacks the stalks, sheaths, leaves and heads, but it differs in the form and size of the spore balls. The author also points out the distinction between the new species *Urocystis Bolivari* and *U. Agropyri*; the spores of the latter are lighter in colour and smaller in size. A. L. S.

**Data for the Mycological Flora of Cataluna.**—BENITO FERNÁNDEZ RÍOFRIO (*Bot. Real. Soc. Esp. Hist. Nat.*, 1922, 22, 200–4). The writer refers to the work done by Gonzalez Frago and Caballero on the mycology of the Province, and adds his contribution: a first list of fungi already recorded followed by species new to the locality. Practically all the species are microfungi parasitic on the higher plants. A. L. S.

**Overwintering and Dispersion of Cereal Rusts in Subtropical Climates.**—GUSTAV GASSNER (*Zeitschr. Pflanzenkr.*, 1916, 26, 329–74). The author gives a summary of the paper, which includes a discussion of experiments and of literature. In subtropical South America the cereal rusts are *Puccinia triticina*, *P. coronifera*, *P. graminis* and *P. maydis*, which appear regularly every year, but differ in their overwintering. *P. triticina* and *P. coronifera* persist by uredospores. This is not possible for *P. maydis*, as the maize plant is not present during the winter. *Uredo* persistence could not be proved for *P. graminis* either. The cereal plants are there, but they are not in an infectable condition. It is just possible, however, that the rust may persist on certain plants by means of the uredospores. No overwintering by mycelium could be proved for *P. graminis*. Overwintering by teleutospores could not be proved for any of the rusts, nor by means of seed. It is surmised that *P. graminis* and *P. maydis* pass the winter in other climates and the spores are transported by air currents. A long bibliography is appended. A. L. S.

**Dark-spored Agarics. I. Drosophila, Hypholoma and Pilosace.**—W. A. MURRILL (*Mycologia*, 1922, 14, 61–76). The present publication is a continuation of previous papers on the same group of Agarics. *Drosophila*, known in Europe as *Hypholoma*, is represented by eleven species, six of which are European as well as American; the others are evidently endemic in America. The genus is distinguished from

*Hypholoma* by the viscid character of the pileus. Under *Hypholoma* three species, well known also in Europe, are described. The genus *Pilosace* is merely referred to.

A. L. S.

**Green-spored Genus of Gill-fungi.**—W. A. MURRILL (*Mycologia*, 1922, 14, 97-8). Murrill describes a new genus, *Chlorosperma*, which differs from *Schulzeria* (also green-spored) by the absence of an annulus and by the adnate gills. The species *C. olivæspora* (Ellis and Ed.) comb. nov. grows on decayed wood, and has been found in several localities.

A. L. S.

**Dark-spored Agarics. II.**—W. A. MURRILL (*Mycologia*, 1922, 14, 121-62). Murrill continues his study of this group, dealing with two genera, *Gomphidius* and *Stropharia*. Of the first genus three species are European, while four are indigenous to the United States. *Stropharia* is a much larger genus, containing twenty species in the States; a fair number of these also are European. Four of those recorded are new to science.

A. L. S.

**Effect of the Polypore, *Fomes fulvus*, on the Almond Tree in Italy.**—V. RIVERA (*Le Stazioni sperimentali agrarie italiane*, 1921, 54, 114-8; see also *Bull. Agric. Intell. Rome*, 1921, 12, 649-50). This fungus frequently attacks old almond trees in Italy. The branches on which the fructifications appear dry up first, and, as a general rule, the whole tree soon dies. The effect on the tissues of the tree and also on the soil, which it renders toxic, is described. The writer considers that pruning operations carelessly carried out are responsible for the spread of the disease. He recommends, above all, that the pruning knife be sterilized. Little can be done to save a tree once attacked.

A. L. S.

**Research on Atmospheric Fungus Spores.**—KENDO SAITO (*Jap. Journ. Bot.*, 1922, 1, 1-54, 3 pls.). The author in his summary affirms previous findings that the number of spores or conidia in the air varies according to the meteorological conditions. Contrary to expectation yeast cells were more abundant in cold than in warm seasons of the year. They are also more abundant in dry conditions. In strong winds there is considerable increase, while after heavy rain or snowfall there are few yeast cells present in the air. Colonies from air-borne yeasts were made of *Saccharomyces*, *Debaryomyces*, *Pichia*, *Willia*, *Pseudosaccharomyces*, and a considerable number of species of *Torula*. Data are given concerning the collection of all these forms and the results of the cultures.

A. L. S.

**New or Noteworthy Fungi. IX.**—W. B. GROVE (*Journ. Bot.*, 1922, 60, 142-8, 1 pl.). The author continues his studies of *Fungi Imperfecti*. He has recognized a number of recently created genera, and has transferred to them the fungi that accord with the new conception of generic characters. Many new species are described.

(*Journ. Bot.*, 1922, 60, 167-77). Grove in this paper concludes his series on new fungi. The present list includes *Fungi Imperfecti*, Ustilagineæ, Tremellinæ (*Achroomyces carpineus* sp. n.), Ascomycetes with several species new to science, and Hyphomycetes, also with new

fungi. The record for Great Britain has been much extended by these papers, and doubtful points have been cleared up by Grove's helpful notes.

A. L. S.

**New or Rare Fungi from Various Localities.**—C. E. FAIRMAN (*Proc. Rochester Acad. Sci.*, 1922, 6, 117-39). The paper is a continuation of the author's studies on fungi carried out in the laboratory and the field for many years. It contains an account of 50 species, mostly collected in Western New York, many of them new to science, with one new genus, *Amblyosporiopsis*, a Hyphomycete. The last two records are of fungi causing diseases of cultivated plants: *Phoma Dioscoreæ* on stem of *Dioscorea Batatas*, and *Discosea maculicola* on leaves of garden *Impatiens*.

A. L. S.

**Novitas Bryologica.** II.—GYÖRFFY (*The Bryologist*, 1922, 25, 18, 1 fig.). A translation is given of Györfy's account of the presence of *Cladosporium herbarium* in the capsules of *Campylopus introflexus* from Tasmania. Györfy has found the fungus in the capsules of six other moss species.

A. L. S.

**New Japanese Fungi.** XI.—TYÔZABURÔ TANAKA (*Mycologia*, 1922, 14, 81-9). The species described are microfungi belonging to various classes of fungi, Hyphomycetes, Ascomycetes, Phycomycetes and Ustilagineæ. They are all parasitic on leaves or stalks, and are new to science. Some of them are of considerable economic importance.

A. L. S.

**Reliquiæ Farlowianæ.**—ROLAND THAXTER (*Mycologia*, 1922, 14, 99-103). An account is given by the author of the fungi, etc., included in these *Reliquiæ*. They are assorted and made into sets to be distributed to selected institutions and herbaria. Thaxter publishes notes on the specimens when desirable or necessary.

A. L. S.

**Note on the Occurrence of the Finger and Toe Disease of Turnips in Relation to the Hydrogen Ion Concentration of the Soil.**—W. R. G. ATKINS (*Sci. Proc. Royal Dublin Society*, 1922, 16, 427-8). The note follows on a long paper concerned with the acidity or "Hydrogen Ion Concentration of Plant Cells." The writer tested the soil of two fields, in one of which the crop of turnips was badly infested with finger and toe, while the other, close at hand, was free from disease. In the former field the soil contained 0.17 p.c. of calcium, in the latter 0.40 p.c. He thus proved the direct benefit of lime as a remedy for the disease.

A. L. S.

**Bionomics of the Conidia of *Phytophthora infestans*.**—PAUL A. MURPHY (*Sci. Proc. Royal Dublin Society*, 1922, 16, 442-66). It had been observed that tubers contaminated by soil or by diseased foliage suffered serious rot in storage. The present paper deals with the viability of the spores of *Phytophthora infestans* under different conditions of soil, moisture, temperature, presence or absence of oxygen, etc. It is reckoned that the conidia, mingled with soil and kept out of doors, may remain viable and capable of infecting potato tubers for a period between three and four weeks. The other factors affecting viability are discussed and results of experiments are given.

A. L. S.

**Germination and Growth of Fungi at various Temperatures, etc.**—W. BROWN (*Ann. Bot.*, 1922, **36**, 257–83). The author gives results of many laboratory experiments with *Botrytis*, *Fusarium* and *Alternaria*, the fungi on stored fruits. He records that oxygen pressure has little effect on their germination and growth; that their growth is retarded by carbon dioxide, and more especially at low temperatures, in a weak nutrient or in a dense sowing of the spores. The economic importance of the paper refers to gas storage, which, as indicated by the writer, may be most effectively used in combination with cold storage, and will also give the best results when the fruits to be stored are free from growing fungi. A. L. S.

**Sexuality of Basidiomycetes.**—PLANTEFOL (*Ann. Sci. Nat. Bot.*, 1921, sér. 10, **3**, xxxiii–xli). The writer has taken up and completed a paper projected by the late Professor L. Matruchot on the work of Mdlle. Bensauade. He gives a full account of the work on the fusion of nuclei in the mycelium of *Coprinus fimetarius* by means of bridging clamps between neighbouring cells of the mycelium near the growing points of the filaments. This is regarded as fecundation by the union of two cells, similar to what occurs in the Uredineæ. The two nuclei of the united cells form a dicaryon. A. L. S.

**Studies in the Physiology of Parasitism. VIII. On the Exosmosis of Nutrient Substances from the Host Tissue into the Infection Drop.**—WILLIAM BROWN (*Ann. Bot.*, 1922, **36**, 389–99). The writer has studied the question of the effect of the host on the fungus before penetration by the latter. He gives an account of his methods and of the various experiments. He summarizes his results:—  
1. Drops of distilled water which have lain on the surface of leaves show increased conductivity. 2. Though there is increase in conductivity, that is not always accompanied by increased capacity of spore germination. 3. Increased germination, however, runs parallel with conductivity. 4. The ease or difficulty of wetting the leaf surface is an important factor. 5. Indirect proof of the exosmosis of nutrient matter can be obtained by a study of the incubation times of infection in different cases. 6. The rate of exosmosis into drops containing *Botrytis* spores is identical with that into spore-free drops, up to and for some time after penetration by *Botrytis* has taken place. The rate of exosmosis then increases with great rapidity in the case of the infection drops. A. L. S.

**Penicillium glaucum and War-bread.**—H. K. (*Zeitschr. Pflanzenkr.*, 1916, **26**, 99–102). The addition of an undue quantity of potato flour to rye-bread during the war induced the growth of *Penicillium*, owing to the greater moisture of the bread. The writer discusses the chemical contents of the various kinds of flour—wheat, rye and potato—with their water-content, and gives also an account of the action of the fungus on the bread. A. L. S.

**Further Research on the Variations of some Species of Micro-mycetes.**—ELISA MUTTO and GINO POLLACI (*Atti Ist. Bot. Pavia*, 1920, **17**, 53–7, 1 pl.). The authors have made a series of cultures on

different media with *Phyllosticta pirina*, and they find that the form of the spores varies with the medium used in cultivation. Thus the normally colourless simple spores of *P. pirina* may become septate and slightly coloured, and finally there may be produced a macrosporoid form with coloured spores similar to those of *Macrosporium*. A. L. S.

**Fungus Present in Pellia epiphylla.**—W. F. F. RIDLER (*Ann. Bot.*, 1922, **37**, 193–207, 8 figs.). The cells of the thallus of *Pellia epiphylla* contain a fungus which occurs in a definite zone along the thickened median portion towards the ventral surface of the thallus, and in the rhizoids, also in proximity to the antheridia and archegonia. The fungus has been isolated and identified as a species of *Phoma*. The writer allows that the relationship between host and fungus may be a symbiotic one; but the *Phoma* is probably the dominant partner and of little use to the *Pellia*, and in extreme cases it destroys the host.

A. L. S.

**Fungi from New Caledonia.**—ELSIE M. WAKEFIELD (*Journ. Linn. Soc.*, 1922, **46**, 88–93). The fungi were collected by R. H. Compton, and bear out a statement already made that the affinities of the fungus-flora are chiefly with that of the tropics of the old world. There are thirty-three species listed, nine of which are new records for the island. The author describes two new species, *Clavaria flabellata* and *Encelia neo-caledonica*.

A. L. S.

**Quick Method of Determining the Colour of Spores.**—LÉON AZOULAY (*Bull. Soc. Mycol. France*, 1921, **37**, 146–8). It is often necessary to determine exactly the colour of spores in Agarics: the author explains his method of doing this in the field. He tears a piece of paper to give it an uneven edge, moistens it and passes it between the gills of the fungus. The spores adhere in masses and the colour shows up clearly. Other methods are to use a brush or a piece of damp cloth, etc.

A. L. S.

**Dried Fungi in the Paris Market.**—MARTIN-CLAUDE (*Bull. Soc. Mycol. France*, 1921, **37**, 148–9). The fungi in question, *Boletus edulis*, were offered for sale in thin slices dried in heated air. By soaking in water they regained their size and appearance, and were as pleasant to eat as those freshly gathered.

A. L. S.

**Boleti with Red Pores and Red Russulæ.**—P. BRÉBINAUD (*Bull. Soc. Mycol. France*, 1921, **37**, 149–55). The author contributes a series of observations on the colour of these fungi, on the changes that the colour may undergo, on the formation of the network of markings on the stalk, and on the underground mycelium. He gives suggestive notes on associations with earth-worms, etc.

A. L. S.

**Mycological Notes.**—C. G. LLOYD (*Cincinnati, Ohio*, 1922, **7**, 1105–36, 16 pls.). C. G. Lloyd gives photographs of W. A. Setchell and of the Japanese mycologist, A. Yasuda. He publishes short notes on a vast number of specimens received from every quarter of the globe. The forms under observation are illustrated by photographs (about 120 or more are reproduced), and give a vivid representation of the fungi dealt with, many of them rare forms.

A. L. S.

**New Identifications of Mycorrhizal Fungi.**—BENIAMINO PEYRONEL (*Bull. Soc. Mycol. France*, 1921, **37**, 143-6). The author has succeeded in tracing the connexion between the mycorrhiza of forest trees and several well-known Hymenomycetes. For five forest trees he finds eighteen fungi that provide the mycorrhiza. He gives an account of the way in which he identifies and connects up the fungus with the mycelium in the tree roots. A. L. S.

**Decaying of Mulberry Buds.**—GIOVANNI BRIOSI and RODOLFO FARNATI (*Atti Ist. Bot. Univ. Pavia*, 1920, **17**, 185-201, 14 pls.). The deterioration of the buds has been considered as due to weather conditions, etc., but the authors have proved by observation and experiment that the trouble is due to a fungus, *Fusarium lateritium*. They found associated with *Fusarium* the Pyrenomycetous fungus *Gibberella moricola*, and were able to prove by cultural growths that it was the perfect stage of the *Fusarium*. Full descriptions are given of the effect of the fungus on the tissues of the host. The authors recommend the careful removal and destruction of all affected parts of the tree. A. L. S.

**Observations in Malaya on Bud-rot of Coco-nuts.**—A. SHARPLES and J. LAMBOURNE (*Ann. Bot.*, 1922, **36**, 55-70, 6 pls.). The writers recount the various theories as to the origin of Bud-rot, the disease having been attributed either to bacteria or to *Phytophthora*. From their own experiments they were unable to isolate a fungus, but three organisms appeared in the cultures, one producing a deep red pigment, the second a lemon-coloured growth, the third pure white. They consider that Bud-rot may be due to different organisms in different localities. A. L. S.

**Alternaria Spots of Tomatoes in California.**—BRUCE DOUGLAS (*Phytopathology*, 1922, **12**, 146-8, 1 fig.). The spotting occurs soon after the first autumn rains or fogs. The spots remain firm and dry until secondary fungi and bacteria enter, when the fruit goes down with a watery decay. Leaves and fruits were inoculated with the spores, and it was found that while some kinds became diseased others were only slightly affected or entirely immune. A. L. S.

**New Disease of Cacao.**—MALUSIO TURCONI (*Atti Ist. Bot. Pavia*, 1920, **17**, 1-8, 1 pl.). The cocoa plant, *Theobroma Cacao*, belonged originally to tropical America, but it grows more or less successfully in the botanical gardens at Pavia, and it was on one of the plants there that the disease was noted. The leaves were affected, the fungus that caused the disease growing on the leaves and destroying the tissues. The writer gives full descriptions and finally the diagnosis of three fungi: *Physalospora Theobromæ* sp. n., and associated with it *Stachylidium Theobromæ* sp. n. and *Helminthosporium Theobromæ* sp. n. A. L. S.

**Sporotricose of Peaches.**—GINO POLLACCI (*Atti Ist. Bot. Pavia*, 1920, **17**, 203-8, 1 pl.). An investigation of white spots which disfigured peaches at different stages of development was undertaken by Pollacci. He found they were due to a minute white fungus, *Sporo-*

*trichum Persicæ* sp. n. The fungus does not invade the tissues, but the superficial growth prevents the development of the peach at these areas. A. L. S.

**Factors affecting the Production of Apothecia of *Sclerotinia cinerea*.**—WALTER N. EZEKIEL (*Phytopathology*, 1921, 11, 495-9). From experiments the writer has proved that burying mummies (fruit rotted by *Sclerotinia*) inhibits the production of apothecia even if the development of the apothecia has begun before the fruits are covered by the soil. A. L. S.

**Anthracnose of the Garden-Pea.**—FRED REUEL JONES and R. E. VAUGHAN (*Phytopathology*, 1921, 11, 500-3, 1 pl., 2 figs.). The disease which attacks the pods is due to the fungus *Colletotrichum Pisi*, which has appeared lately in Wisconsin. Cultures have been made of the spores, and plants have been inoculated successfully. A. L. S.

**Leaf-spot Disease of Tobacco.**—FREDERIC A. WOLF (*Phytopathology*, 1922, 12, 99-101). The spots were caused by the fungus *Phyllosticta Nicotiana*, brownish zonate spots irregular in outline, varying in size from 1-10 mm. Descriptions of the fungus are given and of inoculation experiments. The disease attacks not only seedlings but also mature plants. A. L. S.

**Banana Freckle in the Philippine Islands.**—H. ATHERTON LEE (*Phytopathology*, 1922, 12, 101-2, 1 fig.). The freckling of the bananas is due to the presence of black spots on the surface of green and also of mature fruits. On the spots occur pycnidia resembling *Phoma musæ*. The disease is widespread in Oceania. A. L. S.

***Sclerotinia minor* sp. n. Injurious to Lettuce, Celery and other Crops in the United States.**—I. C. JAGGER (*Journ. Agric. Research*, 1920, 20, 331-4, 1 pl.; see also *Bull. Agric. Intell. Rome*, 1911, 12, 647-8). The fungus caused destructive rot of the growing plants, producing the same effect as the species *Sclerotinia Libertiana*, but with smaller sclertia and a much more rapid rotting of the host plant. It has been found that many plants are subject to attack. A. L. S.

**Biochemistry of Plant Diseases.**—J. J. WILLAMAN and W. M. SANDSTROM (*Bot. Gaz.*, 1922, 73, 287-307). The writers have studied in this paper the effect of *Sclerotinia cinerea* on plums. They considered that the host might contain or produce repellent substances, such as tannins, acids, antienzymes and antibodies, or that the host might fail to furnish the proper kinds and amounts of nutrients for the normal development of the fungus, and therefore they attacked this problem of resistance and of susceptibility from the standpoint of the parasite. The cultures and chemical analyses are carefully recorded. They note that when the fungus rots the plum some well-marked changes in composition took place in the tissues; the juices showed decrease in specific gravity, in true acidity, a decrease in titratable acidity of greater magnitude than the decrease in true acidity, and an increase in oxalic acid content. The fungus prevents the usual formation of tannin in

the fruit, and converts a portion of the non-protein nitrogen of the host into protein nitrogen in its own mycelium. Nitrites could not be detected.

A. L. S.

**Wojnowicia graminis on Wheats in the United States.**—H. H. MCKINNEY and A. G. JOHNSON (*Phytopathology*, 1921, 11, 505-6). The writers were investigating the occurrence of take-all, *Ophiobolus graminis*, on wheat, and found the pycnidia of another fungus infecting the same spots. It has been surmised that the two fungi are genetically connected, but the writers of the paper have not yet come to any conclusion on that subject.

A. L. S.

**Cercospora Leaf-spot on Egg-plant.**—COLIN G. WELLES (*Phytopathology*, 1922, 12, 61-5, 2 figs.). This rather serious attack on leaves was discovered in the Philippine Islands at the Experiment Station for the Agricultural College. It resembled outwardly the damage done by *Phyllosticta hortorum*, but was proved to be caused by *Cercospora melongenæ*. It injures the plant by reducing the photosynthetic tissue of the leaves. A Siamese variety of the egg-plant with round yellow fruit was not so seriously attacked. Bordeaux mixture checked the disease.

A. L. S.

**Septobasidium on Pinus Strobus.**—WALTER H. SNELL (*Mycologia*, 1922, 14, 55-60, 3 pls.) The fungus grew on the bark of white pine. It is a northern form of *Septobasidium*, most of the species being tropical or subtropical. It was found in New Hampshire, and the writer has worked out the development by cultures. Other species of *Septobasidium* grew on scale insects, and examination of the pine bark showed that the present species, *S. pinicola*, was also associated with such insects.

A. L. S.

**The Take-all Disease of Cereals and Grasses.**—R. S. KIRBY (*Phytopathology*, 1922, 12, 66-88, 3 pls., 3 figs.). The disease due to the fungus *Ophiobolus cariceti* has been found on wheat, doing considerable damage. None of the forms or varieties of *Triticum* have been found to be immune. Investigation proved that seeds from diseased plants did not carry the disease, nor did soil carry the disease after eight months, but bits of infected straw were very effective inocula, and were still effective after eight months. The fungus in culture requires a certain amount of alkalinity, so the use of lime is deprecated. Other means of warding off disease are removal of diseased plants, rotation of crops, etc.

A. L. S.

**Brown Rot of Apricots.**—W. L. HOWARD and W. T. HORNE (*Univ. California Publications*, Bull. No. 326, 1921, 73-88, 5 figs.). The disease is due to the fungus *Sclerotinia cinerea fructigena*, and to the conidial stage *Monilia fructigena*. It has been frequently described, but the present pamphlet deals somewhat exhaustively with the methods employed for overcoming the disease. It attacks the flowers, fruit and twigs, chiefly in moist weather, and in California occurs only in districts near the sea. It was found that spraying either with lime-sulphur or Bordeaux mixture was effective, when applied at the time when the

trees were coming into bloom. In addition all diseased twigs or fruits should be cut out and burned, as they are the sources of new infection. This should be done at the time of pruning, and all twigs or mummified fruits—i.e. fruits shrivelled up by the fungus—should be collected from the ground and burned.

A. L. S.

The "Browning" and "Stem-break" Disease of Cultivated Flax (*Linum usitatissimum*) caused by *Polyspora Lini* g. et sp. n. —H. A. LAFFERTY (*Sci. Proc. Roy. Dublin Society*, 1921, **16**, 248-74, 3 pls.). The great increase of flax cultivation in Ireland during the war led to the appearance of much disease of the fibres. The writer of the paper has devoted much attention to some of these diseases. Two symptoms, (1) "browning" (a turning brown of the plants before pulling time), and (2) "stem-break" (the fracture of the stems), have been traced to the action of the Hyphomycetous fungus *Polyspora Lini*. It is the seeds of the flax that carry on the disease, and the fungus has been found on seed of plants that had been produced in England and Scotland, as well as on seed purporting to come from Belgium, and also on seeds from other flax-producing countries. The various experiments of culture and of inoculation are described at length. The writer deprecates the use of seed from a diseased crop, but if no other is available the disease may be controlled to some extent by atomizing the seeds with a dilute solution of formaldehyde before sowing.

#### Lichens.

Research on Lichens of the Family Stictaceæ—FERNAND MOREAU (*Ann. Sci. Nat. Bot.*, 1921, sér. 10, **3**, 297-376, 3 pls., 20 figs.). The author has made a complete anatomical study of the different members of the family; he has examined histologically seven different types, and is inclined to make the family one large genus with various subgenera. Moreau has also made a comparative study of the reproduction; he finds a trichogyne formed from the ascogonium which reaches the surface but degenerates without any evidence of copulation. Frequently the ascogonium itself degenerates. The various types of algae in thallus or cephalodia have also received attention; he concludes that these live in symbiotic union with the lichen fungus, though he qualifies that statement by comparing the union to a gall structure or biomorphosis—only in the lichen it is the fungus that is incited to undue and abnormal growth. Further research he holds is necessary to determine the development of the thallus, or rather the development of the symbiotic relationship.

A. LORRAIN SMITH.

Lichens Living on Glass and their Mechanical Action on Church Windows.—ETHEL MELLOR (*Comptes Rendus*, 1921, **173**, 1106-8). The writer has determined 22 vitricole lichens, including *Ramalina* sp. *Xanthoria*, *Placodium*, etc. She has found a new species, *Caloplaca vitricola*, with its new variety, var. *violacea*. The diagnoses are not given in the paper. She notes the corrosive action of the lichens on the glass, which may be affected to a depth of 1.6 mm.; the greatest width of a corroded area was 5 mm. Mellor finds that glass has a

strong affinity for humidity, and is affected by the carbonic acid of the atmosphere, an effect that is accelerated by the lichen growth. The lichen is closely applied, and, as it burrows, it lifts minute flakes of glass which can be seen incorporated in the tissue. A yearly cleansing of the windows should be sufficient to remove all lichen growth.

A. L. S.

**Corticolous Graphidaceæ.**—G. BIORET (*Ann. Sci. Nat. Bot.*, 1922, sér. 10, 4, 1-65, 11 pls.). A careful and detailed account of the genera of Graphidaceæ that grow on bark, usually under the bark (hypophloeodal). There is considerable difference in development of the vegetative thallus among these genera, that of *Graphis* reaching the highest stage, while *Aorthonia* is the least advanced. The nature of the substratum—rough or smooth bark, etc.—exercises undoubted influence on the development. The author agrees with Lindau that the hyphæ of the lichen do not dissolve the walls of the host cells; they penetrate by means of accidental openings. In his summing up he notes the action of heredity, more marked in the reproductive organs, and of adaptation to surroundings which mainly affects the thallus. The plates are most of them coloured, and add greatly to the interest of the paper.

A. L. S.

**Physiological Researches on Lichens.**—EVA MAMELI (*Atti Ist. Bot. Univ. Pavia*, 1920, 17, 147-57). The author is dealing with carbohydrates, and has tested a large series of lichens for these bodies by means of various reagents which she describes. In addition to lichenin and isolichenin she has determined the presence of three other carbohydrates. 1. Glycogen: this substance she has found more or less abundant in the gelatinous substance of homoiomerous lichens—that is, of those associated with Cyanophyceæ, *Collema*, *Leptogium*, *Synalissa*, etc. 2. Starch she found in many heteromerous lichens, either in the gonidia or in close relation with them. 3. Amyloid: an insoluble amyloid was found to be present in the hymenium of a large series of lichens; it gives the blue reaction with iodine so characteristic of lichen asci. Finally, the author states that the quantity of glycogen and starch present in the thallus is in direct relation to the photosynthetic process.

A. L. S.

**Critical Note on some Modern Theories as to the Nature of Consortism in the Lichen Thallus.**—EVA MAMELI (*Atti Ist. Bot. Univ. Pavia*, 1920, 17, 209-26, 1 col. pl.). There is first a review of the various theories propounded by lichenologists as to the parasitic or symbiotic relation of the fungus to the alga. The author then proceeds to give the results of her own researches on the lichen thallus. She finds dead algæ occurring sporadically in the thallus, but their presence does not in her opinion affect the question as to the nature of the association with the fungus; they are to be found chiefly in the deeper layers of the thallus, and may have succumbed to the want of light, and also in colonies of algæ the number of dead cells is equally abundant. The writer found very rarely any haustoria from the fungus piercing the algal cells, so rarely that the question of parasitism is ruled

out in the consideration of the lichen thallus; she argues therefore for the systematic position of lichens as a special group of plants.

A. L. S.

**Chemical Study of Blue-green Algæ and Lichens.**—EVA MAMELI (*Atti Ist. Bot. Univ. Pavia*, 1920, 17, 262-3). In a note at the end of her paper on blue-green algæ Mameli adds her experience of blue-green lichen gonidia. Though the lichen hyphæ are subject to modifications in content and form, the algæ suffer no important change, except occasionally in the size of the cells. The Cyanophyceæ in the lichen thallus do not differ from free Cyanophyceæ. She finds pectic substances in these algæ, and in some cases hemicelluloses in the mucilage surrounding the alga.

A. L. S.

**Lichens of New Caledonia.**—A. LORRAIN SMITH (*Journ. Linn. Soc.*, 1922, 46, 71-87). The lichens collected by R. H. Compton in New Caledonia number 110 species or varieties; about half of them are new records for the island, and 1 genus and 20 species are new to science. The new genus *Lepidoleptogium* is paralleled by *Lepidocollema*. The writer was able to confirm Müller-Argau's view that air-currents transported particles of lichen thallus from South America to Africa and thence to Oceania. New Caledonia seems to have an abundant lichen-flora.

A. L. S.

**New Lichen from an Unusual Substratum.**—BRUCE FINCK (*Mycologia*, 1922, 14, 95-6). The lichen described, *Thelocarpon fimicola* sp. n., was found by the writer growing on cow-dung in Kentucky. It was associated with *Protococcus* which it had parasitized, but there was no evident thallus. The spores were numerous in the asci, and very minute.

A. L. S.

**Lichens of the Lake George Region.**—STEWART H. BURNHAM (*Bryologist*, 1922, 25, 1-8). The district lies in the State of New York, and many collections of lichens have been made there. Burnham makes use of previous work, and adds his own results. The present list includes 100 species. It is interesting to note the large number of European species. Habitat and locality are given, along with the collectors' names.

A. L. S.

**Determination of Lichens in the Field.**—W. WATSON (*Journ. Bot.*, 1922, 60, Suppl. I., 1-16). The author has prepared a key to lichens mainly with a view to helping ecologists to recognize and determine these plants in the field. He gives helpful field notes. So far it is the genera that are dealt with, though many species come under review.

A. L. S.

**Lichens of Sardinia.**—EVA MAMELI (*Atti Ist. Bot. Univ. Pavia*, 1920, 17, 159-73). The list is drawn up from a collection made by the author in 1906, and from records of Sardinian lichens by Italian lichenologists such as Garovaglio and others. Altogether the species found on the island number about 400. A first series is published in this paper, which includes occasional biological notes.

A. L. S.

**Lichens of Cirenaica.**—EVA MAMELI (*Atti Ist. Bot. Univ. Pavia*, 1920, **17**, 175–83). This is the second contribution to the lichens of Cirenaica, and the list comprises species collected by the Rev. P. D. Vito Zanow in 1917, and by Doctor Armando Mangin in 1919. Four species and eight varieties are new for the Libyan country, and the genus *Anaphychia* is recorded from there for the first time, with three species and one variety.  
A. L. S.

#### **Mycetozoa.**

**Mycetozoa of New Caledonia.**—G. LISTER (*Journ. Linn. Soc.*, 1922, **46**, 94–96.). The collection contains ten species which were found by R. H. Compton in the high forest within 30 miles of Nouméa, and all on dead wood or leaves. It seems that in the lower lying woods the moisture is too great. The author gives interesting notes on the species, and finds that the remarkable constancy of the specific characters of the Mycetozoa is confirmed by her examination of the various specimens.  
A. LORRAIN SMITH.

# PROCEEDINGS OF THE SOCIETY.

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## AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT NO. 20 HANOVER SQUARE, W., ON  
WEDNESDAY, JUNE 21ST, 1922, PROFESSOR F. J. CHESHIRE,  
PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed by the President.

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The nomination papers were read of seven Candidates for Fellowship.

---

**New Fellows.**—The following were elected Ordinary Fellows of the Society :—

Mr. J. Nelson Arnold, F.P.C., M.S.P.

Mr. Godfrey Hecht.

Mr. James W. Low, B.Sc.

---

**The Deaths** were announced of—

Dr. William Carruthers. Elected 1880, and President of the Society for the years 1900 and 1901.

Mr. T. B. Rosseter. Elected 1883.

On the motion of the President those present rose in their places as a mark of sympathy with the relatives.

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**A Donation** was reported from Messrs. Balliere, Tindall & Cox of "Modern Microscopy" (Cross and Coles), new edition.

Thanks were accorded to the donors.

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**The Report** of the work of the Metallurgical Section for the past session was received and adopted.

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Messrs. W. Watson & Sons, Ltd. exhibited a Mechanical Condenser Mount with Centring Fittings, which they had made to the design of Captain F. Oppenheimer, I.M.S.

The following papers were read :—

**Mr. A. Chaston Chapman, Pres.I.C., F.R.S., F.R.M.S.—**

“The Use of the Microscope in the Brewing Industry.”

**Mr. A. Brooker Klugh—**

“The Plunger-Pipette.”

(Read by Dr. Murray.)

**Mr. E. A. Spaul, B.Sc.—**

“The Gametogenesis of *Nepa cinerea* (Water Scorpion).”

**Mr. James Strachan, F.Inst.P., F.R.M.S.—**

“The Microscope in Paper Making.”

Hearty votes of thanks were accorded to the authors of the above papers and to Dr. Murray.

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The President announced that the Rooms of the Society would be closed for the Summer Vacation from August 21 to September 16.

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The business proceedings then terminated.

COUNCIL  
OF THE  
ROYAL MICROSCOPICAL SOCIETY.

ELECTED 18TH JANUARY, 1922.

---

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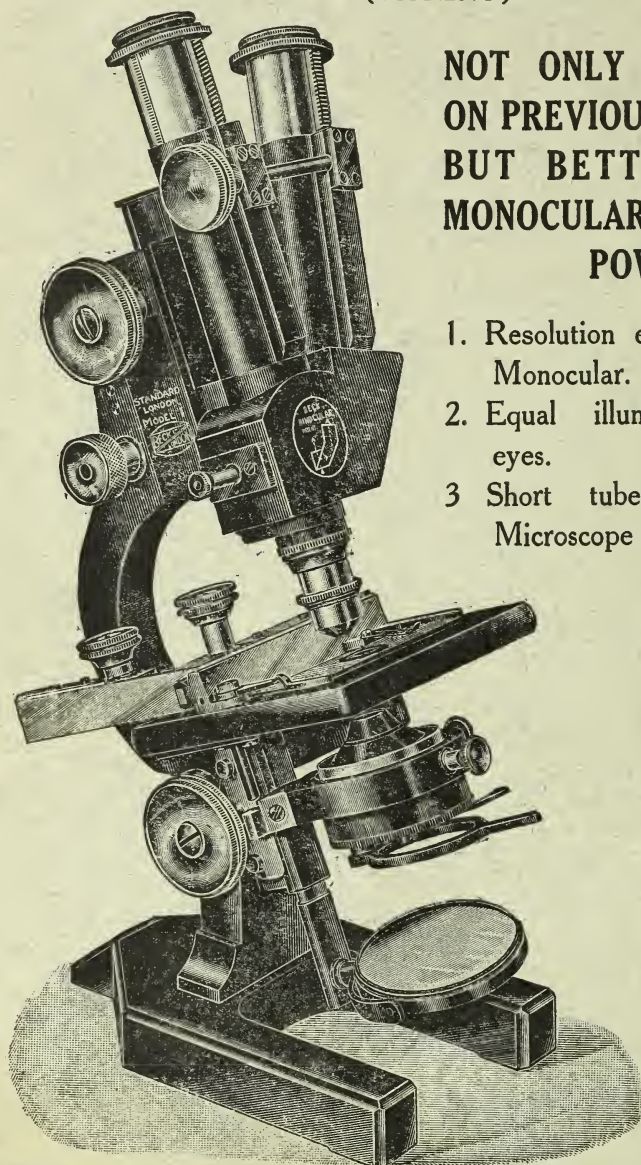
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# Journal of the Royal Microscopical Society

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS

AND

A SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

MICROSCOPY, &c.

EDITED BY

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*Keeper, Department of Botany, British Museum*

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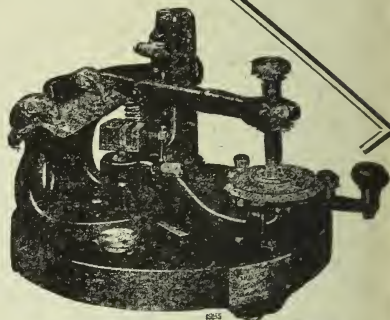
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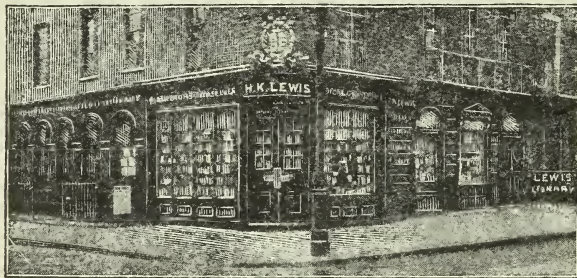
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ANNUAL SUBSCRIPTIONS.—The Fellows of the Society are reminded that Annual Subscriptions become due on the first day of January. Early remittance will be greatly appreciated.

## INDUSTRIAL APPLICATIONS OF THE MICROSCOPE.

A new combined Section of the Society, dealing with the practical use of the Microscope in connexion with Industrial Research, has been formed, and

THE INAUGURAL MEETING will be held at 20 HANOVER SQUARE on WEDNESDAY, 24TH JANUARY, 1923, at 7 p.m., when PROFESSOR FREDERIC J. CHESHIRE, C.B.E., F.Inst.P., Pres.R.M.S., will preside. Practical Demonstrations will be given, Exhibits of Microscopes specially manufactured for various industries will be shown, and communications dealing with Industrial Research will be read and discussed.

Suggestions as to suitable subjects for discussion at the Meetings of this Section, with details of difficulties met with by Fellows and others, are invited by the Honorary Secretaries, Mr. W. E. Watson Baker and Mr. C. F. Hill.

AN EXHIBITION OF SCIENTIFIC NOVELTIES will be held at King's College, Strand, W.C.2, from 28th December, 1922, to 10th January, 1923, in connexion with the United Hospitals Appeal. The assistance of Fellows of the Society who can exhibit slides or apparatus of an interesting character at any of the Evening Meetings will be greatly appreciated. Offers of help should be sent to Professor W. T. Gordon, M.A., President of the Photomicrographic Society, King's College, W.C.2.

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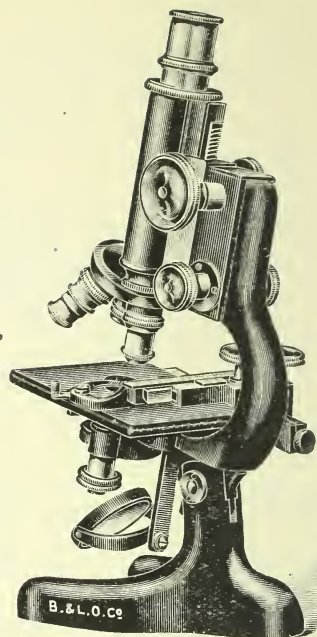
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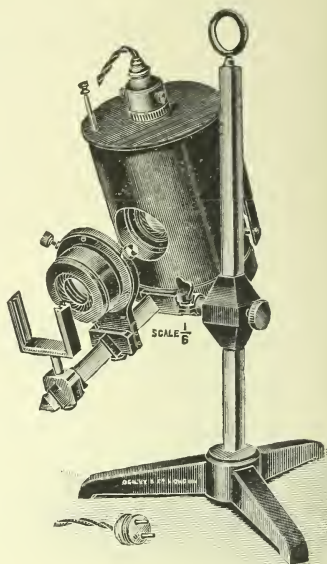
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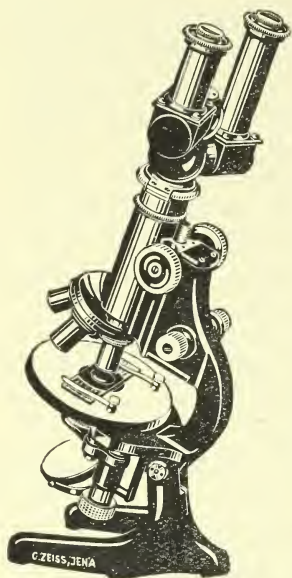
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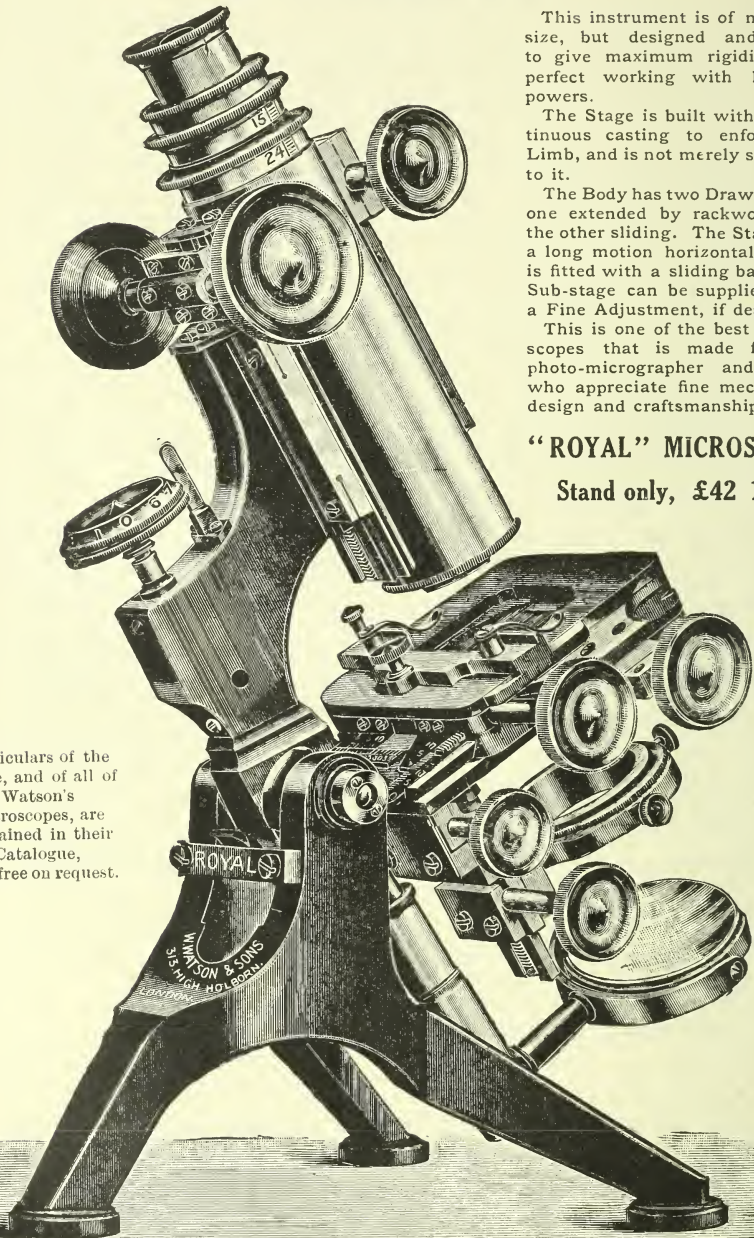
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XV.—LARVA OF CHAOBORUS CRYSTALLINUS  
(DE GEER) (CORETHRA PLUMICORNIS F.).

By SYDNEY CHARLES AKEHURST, F.R.M.S.

(Read October 18, 1922.)

FOUR PLATES AND FIFTEEN TEXT-FIGURES.

THE larva of *Corethra plumicornis* has been of considerable interest to microscopists for the last sixty years, partly because of its transparency, also on account of it being a highly organized aquatic species. (See Pl. XVI., fig. 1.)

The imago is incapable of biting man or animals, and plays no part in the transmission of disease. Probably on account of this *Corethra* has not received so much attention as members of the Culicidæ. Most of the important papers in our own periodicals concerning this larva appear round the period of 1865–1867, with one or two further publications about thirty years later.

Concerning the question of nomenclature, an interesting paper appeared in the *Entomologist's Monthly Magazine*, 3rd Series, vol. vi., by F. W. Edwards, from which we gather the following:—

“CORETHRINÆ.—The name of this sub-family has to be altered, since the generic name *Corethra* must give place to *Chaoborus*, which was established two years earlier. The latter name was founded on the larva only, but the rules of zoological nomenclature lay down the principle that such names are valid, and the rule of priority must be applied to them.”

We now have *Corethra plumicornis* F. re-named *Chaoborus crystallinus* (de Geer), and the other British species as *Chaoborus pallidus*, but, as a matter of convenience, we have retained the more familiar names.

The extremities of the *Corethra* larva are certain to attract the attention of the casual observer: the anal segment on account of its beautifully plumed fin, and the head because of its array of appendages. Most of the latter are employed in hustling the captured crustacean into its capacious jaws. Once inside the mouth, escape is almost impossible. In addition to the interlocking of the finger-like processes on the jaws, there is a suspended screen at the entrance of the mouth, consisting of a number of long chitinous spines, which come into play during the process of passing on the prey, and this prevents any slipping out before the jaws are closed. There are no further hairs in the throat—a clear way exists along the whole of the pharyngeal tube. The juices from the salivary glands then come into play, assisted by a peristaltic movement of the pharyngeal tube, and the food is dealt with. Any indigestible portions, such as the carapace of the water flea, are thrown out by a voluntary action, the ejection being brought about by the eversion of the pharyngeal tube, a rather drastic method for such a simple operation.

On closer examination, it will be noticed that unless reduced to small fragments, the food cannot be passed from the pharyngeal tube to the stomach on account of the œsophagus which intervenes, consisting of a transparent tube of exceedingly small diameter.

Before leaving the head we will refer to the pair of small black pigment spots immediately behind the large compound eyes. These spots persist during the larval stage, and can be seen in the pupa, appearing at the back of the eyes in the perfect insect.

After many failures we captured and mounted our first young specimen. Its length was 2 mm. The only indication of an eye was the black pigment spot, but the amount of light gathered in its area when viewed under the microscope suggested a lens, and, on gently warming the slide, we succeeded in scattering the black granules forming the pigment spot, revealing the lens which had hitherto escaped notice. (See Pl. XVII., fig. 18.)

The next specimen we mounted measured 5 mm., and at this stage of its development the large compound eye was about one-third grown. From this it will be judged the young larvæ have to rely on the simple eye for quite a period after they are hatched. The adult measurement averages 13 mm.—at 5 mm. it would be about half-grown.

It was whilst attempting to catch these very small creatures with a pipette that we appreciated the difficulties of landing them were similar to those experienced in endeavouring to take the fully grown forms, which are provided with two additional large compound eyes.

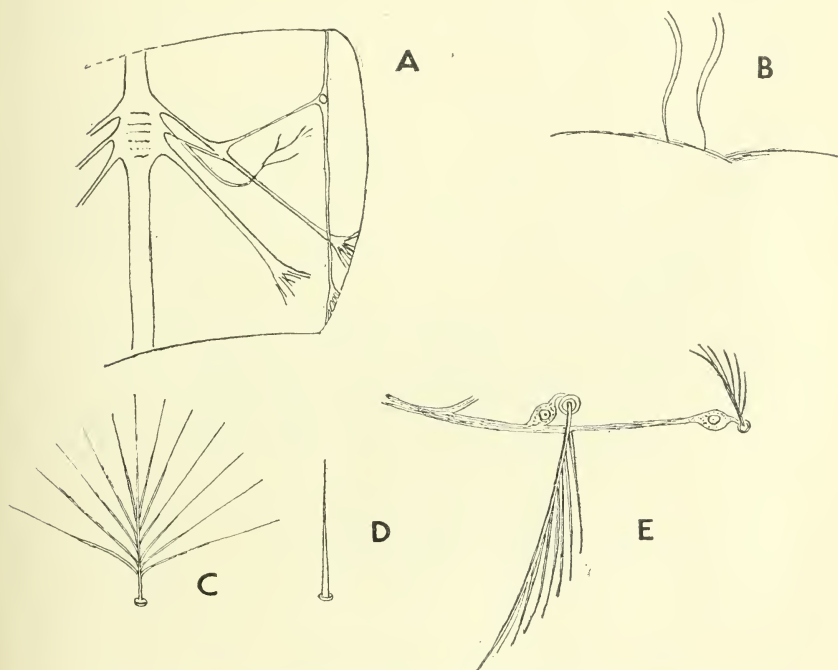
It is also interesting to note that the head of the fully grown larva is somewhat wedge-shaped, the compound eyes being placed

on the most prominent and broadest part, but the thorax is much broader than the head.

When the larva is viewed with the tail pointing towards the observer no eyes will be visible. A sight of any object approaching from the rear would therefore be impossible.

This opened up the question as to the value of the eyes compared with other sensory organs—such as the hairs—in giving warning of approaching objects.

There are instances in pond life where a pigment spot, with or



B, hairs on the dorsal side of thorax of *C. pallida*; A, E, after Graber;  
C, D, explained in text.

without a lens, is all the creatures possess, having neither antennæ nor hairs to assist in locating objects fixed or moving, and in many of such cases there is little attempt to evade an approaching pipette. On the other hand, a young *Corethra* will resort to all the dodges of doubling back and shooting here and there to avoid capture, indicating very strongly there are other means of detecting moving objects than those provided by a simple or compound eye. If we now examine the hairs on the larva we find different forms (C), spreading out almost the shape of a palm leaf on a slender shaft. Another (E) is very curious in its formation, having

hairs distributed on one side of the shaft only. Another is a simple hair undivided (D), and there are several on the thorax, which will be referred to later.

Most of these are in contact with nerve endings arising from the nerve and ganglia running along the ventral side; others are in conjunction with a chordodontal or auditory organ, which occurs in each of several segments (A). This auditory organ commences as a simple nerve, in contact with one of the ganglia referred to; it bifurcates, the two ends attaching themselves to the integument. It is, therefore, in a delicate state of tension, and in a position to register the sensation of any movement transmitted from the outside by hairs attached to the skin, but not directly connected with a nerve.

One can readily appreciate that a *Corethra*—with a supply of sensitive hairs of various shapes attached to the integument and distributed over the body in positions mostly at right angles to the long axis of the body-hairs, which are so delicate and attenuated that it is difficult to make out their endings with a medium-power objective—is equipped to receive the finest impressions transmitted through the water of any moving object coming from any direction.

We will now notice the three pairs of oval patches occurring on the thorax (fig. 6). Although we refer to them as patches, they are really bun-shaped or plano-convex, the flat side directed outwards. These are generously supplied with strands of nerve tissue. On each of the patches are three long and elegantly-shaped compound hairs (fig. 7). We failed to find any reference to these in papers already published.

Drawings were submitted to Mr. F. W. Edwards, and he gave it as his opinion that they were vestigial legs. He referred the matter to Dr. Kielen, who had worked out these vestigial legs on many dipterous larvæ, and he confirmed this opinion, stating that he did not remember whether they had been noted before on this insect. Under polarized light the muscles of this larva show up most vividly. These oval patches remain unresponsive to this form of illumination, demonstrating that there cannot remain the slightest trace of muscular tissue; the transformation, therefore, from a leg to some other organ is absolute.

#### EXPLANATION OF PLATE XVI.

Fig. 1.—*Chaoborus crystallinus* (De Geer) (*Corethra plumicornis* F.).

Fig. 13.—*Corethra pallida*, head of. Zeiss 16 mm. ob. No. E.P.

Fig. 14.—*Corethra plumicornis*, head thrown up, appendages displayed. Winkel 25 mm. No. E.P. Ilford panchro. plate, F. screen.  $\times 28$ . Working aperture 0.17; exp. 30 sec.

Fig. 15.—Normal position of the head.

From each of these patches descends a very robust nerve, which is in contact with one of the three thoracic ganglia. What can be their mission? We suggest they are a further means of recording any outside commotion in the water which may arise from free swimming organisms or other causes.

Having already an auditory organ in several segments registering movements transmitted by a number of hairs, does it need this further apparatus for the same purpose?

Take the antennæ of the male gnat. Why so many hairs? We will refer to Mayer's experiments with this creature, which has beautifully plumed antennæ. He employed a series of tuning

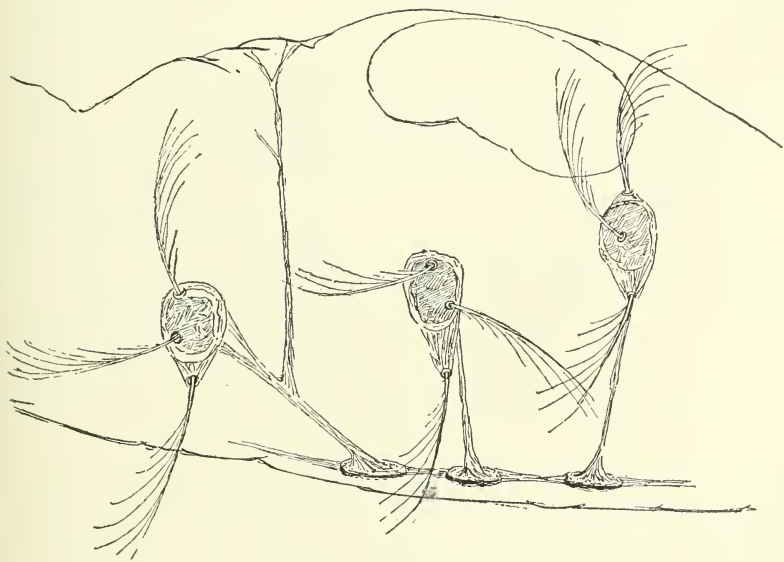


FIG. 6.—Oval patches on thorax are the vestigial legs, with nerves in contact with thoracic ganglia.

forks, and ascertained some of the hairs were thrown into vigorous movement with a fork giving 512 vibrations to the second, whilst others remained nearly stationary. Other hairs vibrated to other notes extending through the middle and next higher octave of the piano. Moreover, those hairs are most affected which are at right angles to the direction from which the sound comes. We tried out the effect of a G tuning fork on ten larvæ confined in a glass tank  $4\frac{1}{2}$  in. by  $5\frac{1}{2}$  in. and  $\frac{3}{4}$  in. wide. When left undisturbed for a period, the creatures arranged themselves in positions parallel with the long sides of the tank, with heads pointing towards the light.

The tuning fork was set in motion and placed against the narrow end of the tank, the sound travelling through the water approaching the larvæ from the rear, and caused an immediate response, the larvæ turning in a very leisurely and apparently interested manner, the tails now pointing towards the light.

This experiment was repeated on other occasions with more or less satisfactory results, and we were convinced that sound arising from a tuning fork and striking the hairs at right angles affects these creatures. If, however, the vibrating prongs of the fork are placed against the glass tank, producing a rattling noise, very little if any notice is taken of it.

It is obviously of considerable advantage to the larva that these organs of sense, which we prefer to call auditory organs,

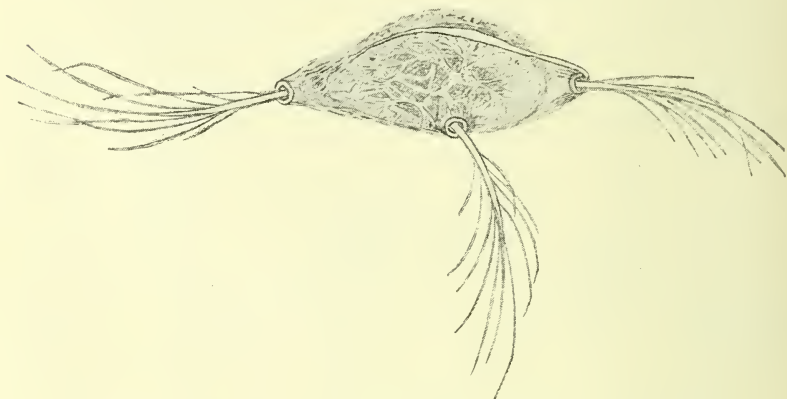


FIG. 7.—Detail of vestigial leg, displaying three hairs.

should be distributed over various parts of the body, in contact with different types of hairs, which would not only enable it to discriminate between the various disturbances set up in the water, but also to locate the direction from which they are coming.

These very delicate hairs covering the body, registering every movement of passing organisms—from the bob, bob, bob of the water flea to the delicate gliding motion and final jump of *Diaptomus castor*—would first indicate the best location, which would probably be followed by the customary flick, the attacker afterwards remaining motionless until the eye registered the exact position before striking.

In some instances neither eyes nor hairs avail. At one o'clock on a certain day we placed a freshly caught larva in a small aquarium. On inspection at 2.30 it had apparently disappeared. After a little searching we discovered it reclining in the tentacles of a green *Hydra*. The body was still held by one tentacle. It

was released and placed in a small hand tank. It appeared to be lifeless, and immediately floated to the surface. We examined it and found it had a huge blister between the thorax and head, the body was swollen, the anal segment twisted, and the head drawn down. Hundreds of stinging cells had been discharged into the head, and parts of the body, which appeared as if powdered with small glass beads. The body contents were semi-opaque, excepting the dorsal side of two segments, which were normal: here no stinging cells had been deposited.

At 7.30 the same day, with the exception of small portions of the digestive track and a few muscle ends, the organs had broken down and appeared like a semi-opaque mass; a small rupture of the integument had taken place, through which oozed the body contents. Was this rapid decomposition normal or due to the injected poison? The latter, we are of the opinion, was the cause. This helps us to understand how the *Hydra* digests apparently impossible meals. On another occasion we witnessed the complete absorption

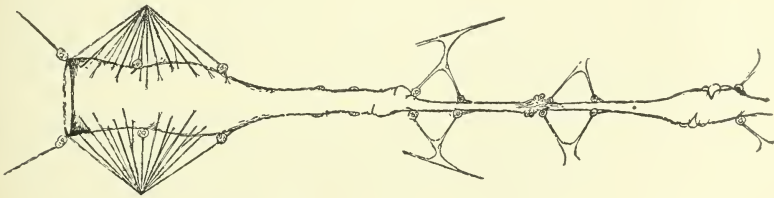


FIG. 8.—Part of dorsal vessel showing valves, also intake as an enlarged sac.

by a *Hydra fusca* of a fully grown larva measuring 12 to 13 mm. The coat of the *Hydra* had been so stretched to effectively cover the larva that the outline of the shape of the latter was clearly defined.

Within a few hours of its meal the *Hydra* was found suspended from some pond-weed, tentacles retracted, its body globular in form, indicating that its prey had been readily digested and converted into a liquid mass.

The dorsal vessel, or heart, runs almost the entire length of the larva, commencing at the eighth segment, whence it can be readily traced through to the head, but it is impossible to precisely locate its termination, as the muscles and other structures completely obscure it (fig. 8).

We have examined specimens not more than two or three days' old—the head then being partly filled with a granulated mass, the muscles not yet being formed—and have still been unable to definitely make out the end, although a slight pulsation just under the place occupied by the compound eye indicated the position, and suggested the nutrient fluid was emitted at that point.

Working back from the head, there are six pairs of valves situate between the two pairs of air sacs; and it was only after prolonged observation, seeing a few of the scanty supply of corpuscles enter, and in no instance pass out of the open valves, we were satisfied they were intakes.

A rhythmical pulsation takes place along the heart, counting from the tail end; the first three pairs of valves open and close very briskly in a series of somewhat jerky motions. The remaining three pairs are sluggish—the opening and closing is just perceptible. During the process of contraction the valve remains closed, but springs open when expansion is almost complete, shutting immediately the maximum diameter of that portion of the heart has been reached. A regular sequence of opening and closing of the valves takes place as the pulsations travel along the vessel. At the eighth segment the heart develops into a sac much larger in diameter than any other part of the organ, the pulsation of which is very vigorous. It is here we find a very beautiful and interesting arrangement of delicate strands, which form an organ of attachment holding the sac in position, and no doubt assisting in its action. These strands are connected at various points to the sides of the sac, converging to a point where they become attached to the integument.

In addition there are two other strands of more robust structure passing out from the entrance of the heart, and also attached to the integument. The rhythmical contraction and extension of these delicate threads, working in perfect harmony with the contraction and dilatation of the heart, is a sight well worth the time and care necessary in setting up the proper illumination and adjustment of the microscope to observe.

The next point of interest is the two pairs of ganglia destined to control the valves and the pulsation of the dorsal vessel, one

#### EXPLANATION OF PLATE XVII.

*Fig. 11.*—*Corethra plumicornis*, anal segment. Winkel 25 mm. obj. No. E.P. Ilford panchro., F. screen.  $\times 36$ . Working aperture 0.17; exp. 2 min.

*Fig. 12.*—Naturally drawn down anal segment. Focus arranged to show detail of hooks extended. Two-thirds obj. No. E.P. Ilford panchro., F. screen.  $\times 120$ . Working aperture 0.21; exp. 8 min.

*Fig. 16.*—*Corethra pallida*, anal segment. Zeiss 16 mm. obj. No. E.P.

*Fig. 18.*—Lens behind granules forming eye spot of young larva. Swift  $\frac{1}{25}$  in. O.I. obj. NA. 1.22 No. E.P.  $\times 800$ . Exp. 20 min.

*Fig. 20.*—Impression of a tube, or cord, round the periphery of the sac. This effect is produced by the formation of the hoops. Leitz 13 mm. NA. 40 Ilford panchro., F. screen.  $\times 80$ . Working aperture 0.35; exp. 1 min.

*Fig. 28.*—Banana-shaped pupal air tubes developed in the thorax of the larva before collapse of thoracic air sacs. Swift 2 in. No. E.P. Wratten panchro., F. screen.  $\times 16$ . Working aperture 0.15; exp. 45 sec.

pair being attached by a short nerve to the region of the dorsal vessel occupied by the valves, and the remaining pair, also by a short nerve, to the vessel itself. These, in their turn, are connected by a peculiar X-shaped nerve, the free ends of which are in contact with the integument.

We made out this structure for the first pair of valves, following the sac, and partly for the second and third pairs; doubtless this structure repeats itself with each pair of valves.

When making out these details, we seldom have used narcotics, but have preferred to allow the larva to remain in the live box for a period of thirty to forty minutes before commencing examination, during which time the creature becomes somewhat accustomed to its confinement.

At first we made many unsuccessful attempts to get a sight of the corpuscles. When the larva is fresh and lively they shoot past the field of the microscope, and, as a rule, are out of focus, it being impossible to judge in what plane in the field they are likely to appear. With confinement in a live box comes a slowing down of action of the dorsal vessel; this in turn produces a sluggish flow of the blood or nutrient fluid, which brings about an accumulation of corpuscles in the neighbourhood of the entrance of the heart. A number of these can then be kept in focus, when it will be observed they slip away in twos and threes more often than singly, in response to the somewhat weakened pulsation.

If you now turn to the valves already referred to you will have a better opportunity of observing their action.

With a flick the *Corethra* can fling itself some distance, or, by a series of continuous and vigorous wriggles, descend from the top to the bottom of the aquarium. Obviously, such a delicate and important organ as the dorsal vessel needs, under such conditions, perfect attachments.

We will now refer to a double row of small, and two large, chitinous hooks on the anal segment (fig. 9). These have been recorded by different writers, but the descriptions are not in agreement, nor altogether complete. "Two chitinous hook-like bodies, and twelve small serrated plates" (2).<sup>\*</sup> "Two hook-like claws inserted on each side of the rectal opening" (5). "Limbs would be superfluous, and nothing can be seen of them except a prominence provided with a double crown of minute teeth which can be distinguished by the microscope at the extreme end of the tail" (4). "*Corethra* larva transparent, last segment usually with hooks" (6). "There is a circle of setæ on the anal segment" (7). From most of the foregoing references the normal position of these hooks would appear to be exterior on the anal segment and fixed.

In all live specimens, in a normal state, these hooks are neatly

<sup>\*</sup> The figures in brackets refer to the bibliography at the end of the paper.

packed away inside a pocket placed on the ventral side of the anal segment, and this is the position they are found in if the larva is first narcotized before being killed and fixed for mounting (fig. 10). Some of the accounts referred to are records no doubt prepared from examination of mounted larvæ which have first been dropped into the killing and fixing fluid and not previously narcotized. Under these conditions an effort would be made to escape from the effects of the surrounding medium, and, in a state of excitement or irritation, the hooks had been forced out.

This is the position of the hooks on specimens I have prepared without narcotization. On two purchased slides and thirty other slides subsequently examined the hooks were internal, as described

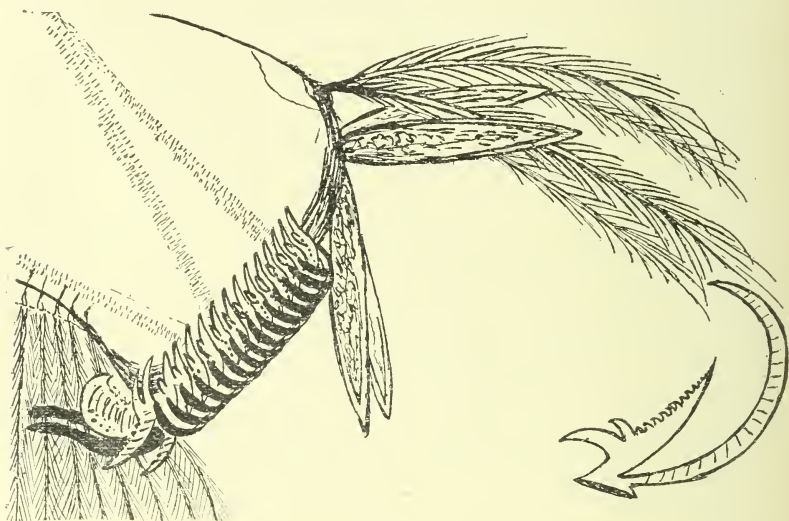


FIG. 9.—Double row and two large hooks on anal segment, with detail of single pair of hooks.

above, and on enquiry we found that the method of preparation included narcotization before killing.

It was necessary to try out some experiments on live specimens before it could be decided whether the organ referred to was fixed or movable. Six larvæ were secured. The first was placed under the microscope in a live box which had a screw-on cover instead of the regular sleeve fitting. This enabled us to apply very gentle pressure, just sufficient to hold the creature across the thorax. The tail end was promptly swung round and held by the jaws, the larva probably being under the impression it had secured the attacking party. At each nip it received from its own jaws the

hooks almost jumped out of the pocket, then were slowly withdrawn. This occurred at least half-a-dozen times.

The remaining specimens all showed the hooks internal. These were dropped into a killing mixture; three of these we examined when dead and found the hooks external. The fourth we took out of the fluid and examined before it was dead, and gentle pressure applied by the cover of the live box caused the hooks to pop out of the pocket and expand; on releasing the pressure they slowly withdrew. From these observations we were satisfied that the hooks are movable, their normal position being inside the pocket,

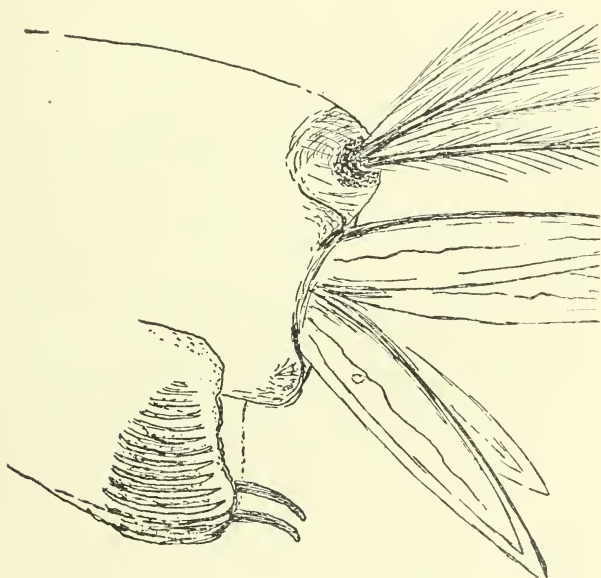


FIG. 10.—Hooks in pocket on ventral side of anal segment.

and not external and fixed as suggested by most of the accounts referred to. Is this a degenerate retractile hooked foot?

“All insects were primarily terrestrial; that some have become aquatic is no doubt due to an acquired habit. Many remain air-breathers, coming to the surface of the water for supplies; others completely changed the tracheal system, extracting supplies of air from the water.

“The transformation of the *Corethra* larva has been complete. It is the only insect larva that has become a free swimmer, and remains so during the whole period of its larval existence.”

We have already referred to the vestigial legs, and we will now carry our minds back to the time when the larva first became

adapted to an aquatic life, and possessed three pairs of legs and ten pairs of stigmata.

Here two pairs of air sacs for hydrostatic purposes would be superfluous; also the very elegantly plumed anal fin would not only be unnecessary, but a hindrance to progress. These, together with the four branchial gills, were later developments.

We now have our larva dependent for locomotion on three pairs of probably stumpy legs, as those existing on other aquatic forms, such as *Dixa*, *Chironomus* and *Tanyppus*. One can readily appreciate that a supplementary foot on the end of a long slender body would be of assistance.

The present normal position of the anal segment on *C. plumicornis* is in alignment with the long axis of the body, which makes it impossible for the larva to use the hooks as a foot. (Pl. XVII., fig. 11.) It can still, however, when necessary, draw the segment down until it is almost at right angles to the rest of the body. In this position the retractile hooked foot could be brought into play. (Pl. XVII., fig. 12.)

We will now refer to *C. pallida*, the larval form of which is very rarely taken owing to its habit of living in dense masses of pond weed.

We were fortunate in securing two in November 1920. They measure 9 mm. The head (Pl. XVI., fig. 13) is shorter, and the muscles in the head are not so robust as in *C. plumicornis* (Pl. XVI., fig. 14), and, in place of the two leaf-shaped appendages in front of the labrum, *C. pallida* has two simple hairs or spines, on each of which, midway, and towards the ends, are a number of very delicate spurs. The anal segments, however, are not straight, but turned down almost at right angles to the body. (Pl. XVII., fig. 16.)

It is more than probable the leaf-shaped appendages in front of the labrum on *C. plumicornis* have developed from the simple hairs or spines, as shown in *C. pallida*. If this is so, it indicates that *C. pallida* is the older species, having its turned-down anal segment in a position to permit the hooked foot to be used, as in the case of the *Tanyppus* larva: the hooks not now being of service have become obsolete, and remain tucked away in the pocket in the ventral side of the anal segment, only being forced out when the larva is in a distressed condition.

Unfortunately when mounting the larva of *C. pallida* the Canada balsam, in running under the cover-glass, swept the plumes together, and the anal segment also became slightly twisted out of shape, as can be seen by the position of the four dorsal chitinous spines on the extreme tail end.

The most striking of the organs which can be readily seen with a hand-lens are the four reniform or kidney-shaped air sacs located in pairs in the thorax and ninth segment respectively. To obtain

a detailed examination of these it is necessary to dissect out the sacs and transfer them in water to a live box. (Pl. XVIII., fig. 17.) The outer covering consists of a snugly fitting gelatinous coat, which is studded with nucleated cells. On the dorsal half only are embedded a number of dark-coloured pigment spots, each having a minute light-coloured centre. These spots are made up of granules, small enough to exhibit Brownian movement when scattered in water. The spots are somewhat circular in shape, or, if congested owing to increased numbers, hexagonal or polygonal, giving a reticulated appearance.

If several larvæ are kept in a tank where light and general conditions are uniform, the pigment spots often vary on each larva—one may exhibit a densely packed collection of spots, and another a meagre supply, indicating possibly a condition of health; on sickly specimens they are usually very scanty.

The next conspicuous detail is a wall of closely-packed and extremely thin hoops, each shaped like a rubber band, all of which are embedded in a transparent tissue. Each hoop has a depth of about three times its width. (Pl. XVIII., fig. 19.)

These hoops are chitinous in nature, responding vividly to polarized light. As they dissolve out in the body fluid of the larva it is improbable they are pure chitin.

We placed a sac in Flemming's fluid. In three hours the effect of the osmic acid was seen on the fatty contents, which must be considerable, as the surrounding water showed a quantity of dense black patches; the fat we believe was dissolved out from the hoops, as they very readily buckled under the slightest pressure. We refer to them as hoops, as their appearance in the transverse sections suggest it rather than a continuous spiral thread. More than one section appears as a complete hoop, which would be impossible if it was a section of a spiral. (Plate XIX., fig. 23.) They are probably invaginations. Around each hoop is bound a spiral band or narrow ribbon of tissue with its edges overlapping. (Plate XIX., fig. 24.) This bandage adds considerably to their strength and prevents them snapping under pressure.

On clearing away the outer gelatinous coat and viewing the sac with an immersion objective, the overlapping edges of the ribbon of tissue appear as slightly projecting extremely narrow collars. With polarized light the appearance is altered to that of thin black lines running transversely across the face of each hoop. (Pl. XVIII., fig. 22.)

If pressure is applied to a sac when in the live box a fracture appears midway between the dorsal and ventral sides; with continuous gradual increase of pressure, the fractures will appear over the entire surface, which, under an inch objective, gives the impression of a piece of watered silk. (Pl. XVIII., fig. 18.)

Examined with one-sixth objective it will be observed the

hoops have buckled into a number of apparently short rods tilted at different angles (Pl. XIX., fig. 25). The band of tissue at the fracture appears as a collar; if the fracture is bad it suggests an elbow joint. This buckling is due to the inability of the hoops to expand. An increase in depth is especially noticeable in the central hoops, which gradually lessens as those occupying the extremities are approached. (Pl. XVIII., fig. 21.)

This formation of the hoops produces a curious effect when viewing the sac as a whole; the impression given is that of a tube or cord running round the periphery of the sac. (Pl. XVII., fig. 20.)

The hoops are entirely covered with a transparent elastic coat, the outer surface of which is slightly corrugated. This transparent tissue also passes between each hoop, holding them together. (Pl. XIX., fig. 26). The longitudinal sections show quite an appreciable thickening of this elastic coat on the middle portion only of the ventral side. The air sac has only two coats, the outer one being of a gelatinous nature which carries the pigment spots, and an inner transparent one strengthened by the embedded hoops.

Viewing the larva with the head to the right, we find on the left-hand end of the thoracic, and on the right-hand end of the posterior sacs, there is attached a knobbed shaped appendage constricted towards the top and tapering away to a very fine point, from which issues an exceedingly delicate capillary tube. This latter, with the whole of the appendage, is enclosed in a large transparent tube. (Pl. XVIII., fig. 17.) At its greatest circumference, we find out that the appendage has a circle of roundish patches of a different structure to that of itself (fig. 33). From its neck there is given off a capillary trachea, a branch from which is carried over the air sac. The other end of the sac is an exit, and to this is attached capillary trachea. If both ends of the sacs are *exits only*, why this important difference in structure?

The appendage, which we will refer to as a valve, is filled with air, and when under examination, surrounded by water, the optical conditions are not all favourable for observing delicate structure. We have, however, made out the continuation of the capillary tube referred to as passing *through the centre* of the valve, and then no doubt into the lumen of the air sac. At intervals along the tube inside the valve appear highly refractive circular bodies (fig. 27). We will refer to this structure again.

A great deal has been written concerning the question of the ability of the *Corethra* to stabilize itself under various pressures, and it will be of interest at this stage to refer to W. N. F. Woodland's paper (11) on "The Structure and Function of the Gas Glands associated with the Gas Bladder of some of the Teleostean Fishes," which will give us an opportunity of comparing the methods of these fishes in maintaining hydrostatic equilibrium

with the hypotheses put forward by those who have investigated the causes of maintaining buoyance of the *Corethra* at various depths. A fish living near the surface, if brought down to a depth of, say, 10 metres, the air in its bladder becomes compressed to one-half its former volume, the buoyancy of the fish is correspondingly diminished, and it will sink; but if it remains for some time at the depth of 10 metres it regains its equilibrium (9).

This adjustment, however, only occurs after a lapse of several hours.

The method of secreting a suitable amount of gas into the bladder to bring this about is described by Woodland, and we extract the following details from his paper:—

“The oxyhæmoglobin is the main source from which the oxygen glands of Teleostean fishes obtain supplies of oxygen in solution, and the cells of these glands cause the dissolved gases to appear in a gaseous form as bubbles in the cytoplasm, the cells

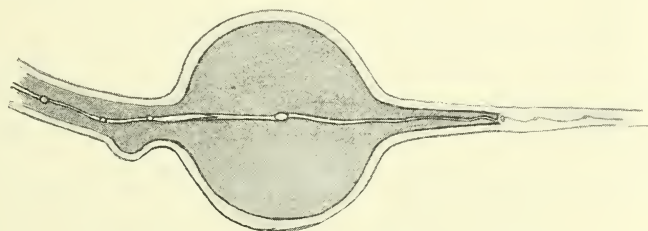


FIG. 27.—Optical section of intake and outlet valve of air sac, showing tube passing through centre, with small round bodies occurring at intervals. Shaded part represents gas.

subjecting these bubbles to greater pressure than that existing in the bladder. When the gas bubbles are expelled into the bladder lumen, and experience a diminution of pressure, they burst.

“Here we have the gas gland cells actually pumping the oxygen into the bladder. These are the conditions that arise with the descent of the fish into deep water. On ascending, the excess oxygen is rapidly absorbed by a body named the Oval, and passed back again into the blood.

“The contents of the bladders have been analyzed and found to contain—in varying quantities, according to species—oxygen, nitrogen, carbon dioxide, and argon. Oxygen, however, is the only gas that can be rapidly produced, hence the excess of this when the fish is subjected to increased pressure.

“In the bladders of Cyprinoids, and many other fresh-water fish, which mostly contain nitrogen, the gas glands are absent, the ordinary squamous epithelial lining here being capable, without undergoing any special modification into a gland, of pumping in the nitrogen alone required. There is no need of an oxygen gas

gland for fishes living placid lives in inland lakes and rivers, experiencing little or no change of pressure in the bladder."

Experiments that have been carried out on *Corethra*, subjecting it to varying pressures from + 33 cm. to 2 atmospheres, the latter being equal to 10 m. of water, recovery of equilibrium has taken place after periods of from one to twenty hours; but Krogh states equilibrium was seldom re-established if a pressure in excess of + 70 to + 80 cm. was employed.

The larvæ we have captured have been taken from shallow ponds, none of them having a greater depth than 5 feet, and at the edge, within the limits of the reach of a hand net, the depth should be about 2 to 3 feet. It is around the edges of these ponds we have landed our catches.

It is obvious that, under such conditions, should the larva descend to any part of the bottom—which is its invariable custom on being scared—the amount of pressure it would sustain would be inconsiderable, and, owing to the nature of the construction of the air sacs, no compression would take place.

If, for experimental purposes, the larva is subjected to abnormal pressures, the question arises as to what damage the air sacs have sustained. If this is considerable, the natural resilience of the sacs will be to some extent temporarily destroyed, and until the normal shape or form of the sac has been re-established equilibrium is delayed. The period for recovery would be controlled by the extent of the damage inflicted; if this is beyond repair the larva sinks and remains at the bottom. If the pressure should be sufficient to burst the sac, driving the air out, with the removal of the pressure the sac could ultimately expand, and we should then probably find it practically filled with body fluid.

As we have seen, the closely-packed hoops of the sacs are made very resistant by a ribbon of tissue bound spirally round them. When pressure is applied, a definite break of the hoop is avoided, but they will buckle as the pressure is increased. (Pl. XIX., fig. 25.) Ultimately, if the strain becomes too great, the in-between tissue holding the hoops will burst, allowing the contained

#### EXPLANATION OF PLATE XVIII.

Fig. 17.—Air sac: at one end knob-shaped valve, the other is attached to the capillary trachea.

Fig. 18.—Fractured hoops: produced by pressure in live box.

Fig. 19.—Complete hoop with spiral bands (transverse section).

Fig. 20.—Enlarged conchoidal-shaped sac prior to pupation, showing distribution of pigment spots over entire surface.

Fig. 21.—Entire longitudinal section of air sac, showing depth of hoops in middle of sac, which diminishes as the ends are approached.

Fig. 22.—Appearance of hoops under polarized light; overlapping edges of spiral bands as dark lines across the hoops.

air to escape. If the pressure is removed before this stage is reached, the threads will slowly restore themselves to the normal. We have tried this out, placing a sac in water in a live box, applying pressure until a slight rupture has occurred, the greater portion of the air escaping through the aperture. By gently removing the pressure we witnessed a slow expansion and sucking in of water, until more than half the sac was filled.

Krogh has put forward the hypothesis that water may be secreted, and then disengaged, or by a process of osmosis expelled from the sacs, causing the creature to ascend and descend in a similar manner to that of a submarine, with its tanks filled or emptied of water.

We have great difficulty in entertaining this. Such experiments as we have been able to carry out, compelling the creature to rapidly ascend and descend—it remaining stationary at the end of each movement—excludes the idea that any such secretion of water can take place so rapidly as indicated, bringing about an instant change of conditions enabling a larva to establish its equilibrium. We hold to the opinion that, owing to its structure, the sac is rigid, and its action under pressure, when compared with the soft and somewhat flabby gas bladder of a fish, would be different. No alteration of its area takes place with a change of position. On swimming downwards there arises a difference in hydrostatic pressure between the inside of the sac and the surrounding fluid; in other words, diminution of pressure in the sac is set up, and a passing in of a portion of available gas takes place from the four tubes attached to each of the four *rigid* sacs (these tubes we will describe later), and buoyancy is not disturbed. On ascending, the pressure in the sacs being increased, the contained gas would find a natural outlet through the capillary tracheæ, replacing exhausted air due to movement. At the same time, gas in the tubes is being replaced, and equilibrium is, therefore, maintained.

The process of respiration is most active at the same period as the rapid up-and-down movements in the water. These movements being limited, the varying pressures would, in consequence, be small, and the volume of air taken in and expelled from the four sacs at the completion of each change of position would be infinitesimal.

It is well, however, to bear in mind that *Corethra*, under normal conditions, will remain stationary for long periods, and does not indulge in active movements—not even to chase living organisms when hunger must have been acute, we having kept it without food for days. By this habit of remaining stationary it has learned to exist on a minimum amount of oxygen.

Lieut. G. C. C. D. mant (12) kindly drew our attention to a statement made by Wesenberg-Lund in the *Internationale Revue*—

ges. Hydrobiologie, 1908, Bd. 11—that *Corethra* has been taken at a depth of 30 metres, or an equivalent of 6 atmospheres.

As Krogh has demonstrated that this creature usually fails to survive a greater pressure than +70 to +80 cm., we have strong evidence that there are deep and shallow water species.

A remarkable change in the shape of the air sacs commences to take place a few days prior to pupation, the cause of which we have failed to establish. From that of a kidney, they begin to assume a conchoidal form, this being brought about by the fact that the sacs, owing to their construction, can only expand "concertina wise." (Plate XVIII., fig. 20.) The hoops occupying the centre portion become separated, the space between each being about two and a half to three times their width. As the two ends of the sac are approached the distance between the hoops becomes less, and at the extremities separation is hardly perceptible. It is easily observed at this stage that more than every other hoop is forked, the bifurcation commencing mid-way to the dorsal and ventral sides—in other instances near the dorsal—thus providing an increased number of supporting threads at the periphery, the larger outer circumference demanding this.

The expansion is permanent, that is, no ultimate contraction takes place during the remainder of the larval existence.

We have dissected out and mounted the sacs in camphor water plus 1 p.c. corrosive sublimate, and not the slightest indication of expansion has shown itself during a period of over two months, which appears to exclude the idea they are hygroscopic.

With such an increase of the four sacs we should expect the larva to rise and remain near the surface. This consistently takes place when the larva is in captivity, and only a limited food supply available. In two instances, however, on examining freshly caught larvæ, we found the conchoidal shaped sacs. When placed in the tank the creature took up a position near the bottom and remained there. Possibly the larva, on approaching pupation, gorges itself with food, increasing body weight, thereby resisting additional buoyancy of the enlarged sacs. In the pharyngeal tube of one of the above larvæ we found three partly digested Cladocera (*Chydorus sphericus*), and a fourth recently taken was almost intact. Curiously enough, the fourth *C. sphericus*, by a definite constriction of the pharyngeal tube, was shut off from its partly digested friends.

With this increase in size of the sacs the pigment spots are not confined to the dorsal half, but are distributed, and fairly evenly spaced over the whole area of the sacs. (Pl. XVIII., fig. 20.) This may be due to an increased number of spots or to the stretching of the outer gelatinous coat over a larger area, carrying the spots with it.

We think the former suggestion is correct; the expansion of

the sac being "concertina-wise" would hardly drag the spots from the dorsal to the ventral side.

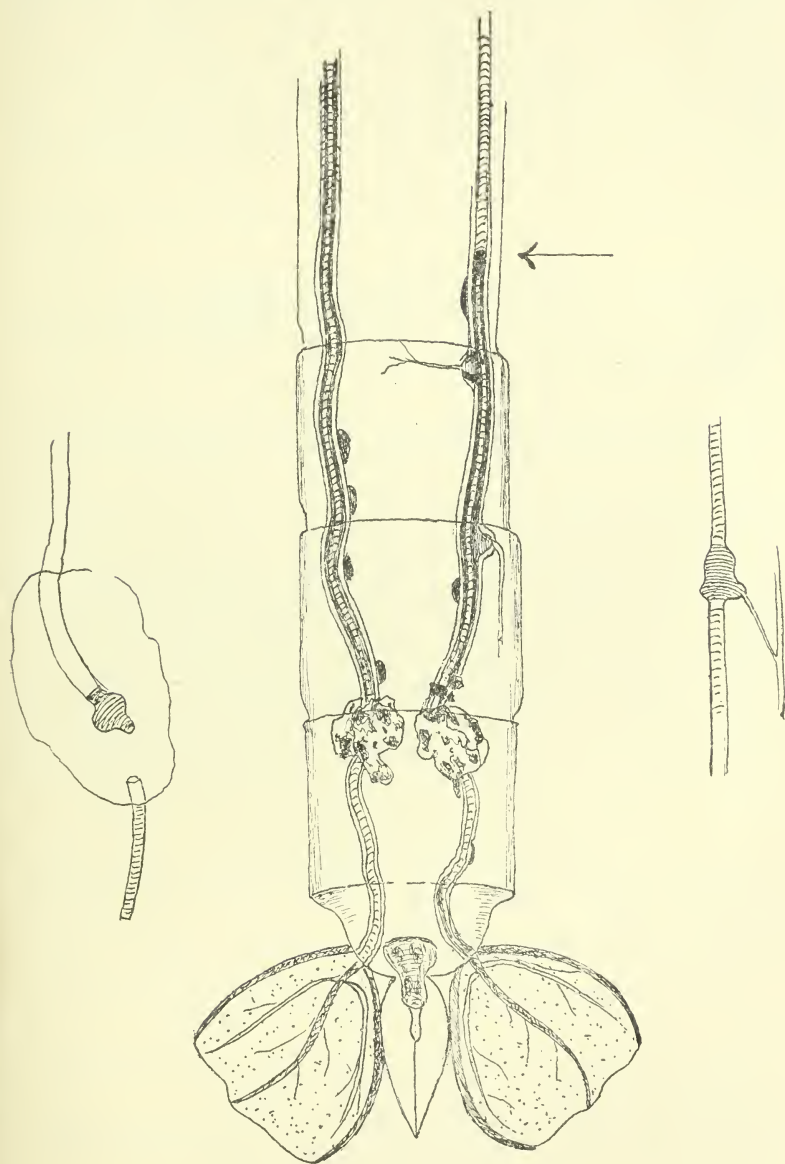


FIG. 29.—Gas from posterior sacs has filled one, but has travelled only as far as the arrow in the other tracheal tube. Some of the pigment spots from the sacs have been carried along and disposed at intervals on the tracheæ.

The significance of this increase in pigment spots becomes obvious on recalling Miall's hint concerning their possible mission. He says: "The pigment upon the air sacs of *Corethra* larva may conceivably help in the respiratory process. Pigment is not unusual in the respiratory organs of insects. The large tracheal trunks of some dragon-fly larvæ are tinged with purple, and the tracheal gills of some caddis worms show a pale violet colour. Gas may be secreted by a chemical process in which pigment plays its part."

With pupation well advanced, we find on dissection the forma-



FIG. 30.—Showing one main pupal tracheal tube complete, the other partially developed, both arising from valve ends of posterior sacs.

tion of the main pair of pupal tracheal tubes arising from the valve ends of the posterior pair of sacs.

We have been successful in taking the larva when it is half larva and half pupa. With the eyes of the pupa towards the observer, the left-hand tracheal tube was complete, whilst the right-hand was only two-thirds completed (fig. 30). On another occasion the tracheal tubes were both completed, but the discharging gas from the right-hand sac had only reached half way up the tube (fig. 29). We also noticed a change in position of the pigment spots, which are now somewhat small, oval, and densely-black bodies. These are distributed from the posterior sacs along the

#### EXPLANATION OF PLATE XIX.

\* *Fig. 23.*—Transverse section of sac, showing hoop complete, suggesting invagination—not part of spiral thread. Leitz  $\frac{2}{3}$  obj. NA. 40, No. "O." E.P. Wratten yellow screen.  $\times 80$ . Exp. 2 sec.

\* *Fig. 24.*—Part of hoop, displaying overlapping spiral ribbon of tissue. Leitz  $\frac{1}{10}$  fluorite NA. 1·30, KI. screen.  $\times 500$ . Exp. 1 sec.

\* *Fig. 25.*—Hoops of the air sac buckling under pressure into short rods. Zeiss D  $\frac{1}{6}$  NA. 65 Ilford panchro., F. screen.  $\times 240$ . Working aperture 0·50; exp.  $2\frac{1}{2}$  min.

\* *Fig. 26.*—Portion of longitudinal section of air sac, showing connecting tissue with parts of embedded hoops. The large granular patches are pigment spots. Leitz  $\frac{1}{10}$  fluorite NA. 1·30, H. screen.  $\times 1000$ . Exp. 20 sec.

† *Fig. 31.*—Longitudinal section, showing integument, outer layer darkly stained (iron hæmatoxylin), indicating it is probably a covering of a fatty nature. Leitz  $\frac{1}{10}$  fluorite NA. 1·30, H. screen.  $\times 1000$ . Exp. 15 sec.

† *Fig. 34.*—Collapsed air sacs. Swift 2-in. obj. Imperial orth., G. screen.  $\times 24$ . Working aperture 0·13; exp.  $1\frac{1}{2}$  min.

\* Taken with arc lamp.

† Taken with thorium disc.

main tracheal tubes, and we can only suggest the movement is due to a flow of the gelatinous coat of the disappearing air sacs along the tracheal tubes. Some of the spots, however, are scattered about on the sides of the pupa.

There is a generous supply of tracheæ from the thoracic pair of sacs; also a pair of banana-shaped air tubes arise, which appear before the collapse of the sacs. (Pl. XVII., fig. 28.) These remain tucked away under the integument on the ventral side of the front of the thorax, awaiting the completion of the change, when, with the slipping of the larval integument, and the adjustment from the horizontal position of the larva to the vertical position of the pupa, they come into play, taking in atmospheric air, but not until the trachea and air tubes have been first cleared by *air discharged* from the larval sacs.

On one occasion we secured a newly-changed larva before it, as a pupa, had an opportunity of reaching the surface to take in atmospheric air. We confined it under water, and kept it from rising to the surface for four days. It was very active during that period, and when we examined it we found the head end was darkening, the legs and wings well developed, also the hairs on them. There was no air in the trachea of the anal fins. These changes developed on the air supply carried over from the sacs of the larva.

Unfortunately, when removing it on the fourth day from the microscope to the tank, it was crushed. With regard to the question of respiration, we have here a problem full of puzzling conditions. Krogh has carried out some exceedingly interesting experiments to demonstrate the diffusion of the gases through the integument of the larva, maintaining that this latter acts as one large spiracle. Prof. Miall (4) also suggested that this might be a possible method of respiration.

Krogh proceeds to demonstrate that the gases in the air bladder come into diffusion equilibrium with any gas mixtures dissolved in the surrounding water, and, consequently, in the fluids of the animals. We give the results of his experiments as under:—

He placed a number of larvæ for a few hours in different bottles, with water saturated with:—

1. 55 p.c. oxygen and 5 p.c. nitrogen.
2. 51·5 p.c. oxygen and 48·5 p.c. nitrogen.
3. Air with 17·8 p.c. CO<sub>2</sub>.
4. Air with 9·5 p.c. CO<sub>2</sub>.

And found by analysis of the air from the bladders in bottle:—

1. 91·5 p.c. and 8·3 p.c. N<sub>2</sub>.
2. 48·0 p.c. O<sub>2</sub> and 51·8 p.c. N<sub>2</sub>.
3. 8·9 p.c. to 6·7 p.c. CO<sub>2</sub> (analysis of two animals).
4. 5 p.c. CO<sub>2</sub>.

From this, "the diffusion equilibrium has in all four cases been practically absolute, and it follows that all three gases can be diffused freely through the walls of the air bladder."

Here, for experimental purposes, we have the larvæ subjected to abnormal conditions. When excessive pressures are employed for the purpose of demonstrating the possibility of diffusion, is it not conceivable that such diffusion might take place through the digestive track?

Krogh, for the sake of comparison with the compression experiments, proceeds to analyze a number of larvæ from an aquarium constantly aerated by atmospheric air, and from eleven examinations found the nitrogen contents varied from 81·8 p.c. to 85·6 p.c., or an average of 83·5, and the oxygen contents about 16 p.c.; in three cases a trace of 0·3 p.c. to 0·7 p.c. carbon dioxide—the bulk of this gas was probably lost by diffusion. This analysis gives results approaching the constituents of free air.

The necessity for rapid examination is obvious, and Krogh states the time elapsing from the seizure of the animal until the bubble was ready for analysis was between 1½ to 3 minutes, and the analysis itself occupied 3 to 6 minutes.

We extract the following from Arber's "Water Plants," which gives an interesting comparison between the constituents of free and dissolved air:—

"Owing to the varying solubility of atmospheric gases, the dissolved air differs from free air in composition. At 15° C. the proportions in which the constituents should occur have been calculated to be as under.

"The proportion of nitrogen given in this table naturally includes other inert gases which were not distinguished in Devaux's time (1889).

"W. H. Brown (1913) suggests the excess of carbon dioxide is derived from the substratum being given off into the (pond) water from soil containing organic matter.

	Free Air per cent.	Dissolved Air per cent.
" Carbon dioxide . . . . .	0·04	2·19
Oxygen . . . . .	20·80	33·98
Nitrogen . . . . .	79·16	63·82 "

We will now review the various tests and examinations that have been made concerning the permeability to gas or water of the integument of *Corethra*.

1. Pupation of larva almost complete—the cast skin hanging from the head of larva—this we subjected to polarized light—skin too thin to respond, but, where folded and creased, polarized vividly, suggesting it is chitin, or contained some fatty substance.

2. Transverse section of larva—shows the integument very lightly stained (iron hæmatoxylin), excepting a thin covering on

the outside—*stained very heavily*, indicating this is fat; hæmatoxylin being one of the fat stains. On the inside there is a layer of cells. (Pl. XIX., fig. 31.)

3. We placed a well-fed larva in glass tank. To this was added some chopped-up larvæ—the top of the tank was plugged to avoid evaporation. This was kept in a room with night and day temperature of about 65° F. The water soon became foul and milky in appearance. At the end of ten days the creature was still vigorous and lively.

4. E. J. Sheppard noticed when cutting sections of this larva that the integument had a tendency to break up in a similar manner to that of the chitinous coat of the flea, of which creature he had cut many hundreds of sections.

Other references to this question are given in Frankenberg's paper, from which we have extracted the following details:—

"I refer to the power of resistance of the apparently delicate body wall of *Corethra*, which is, contrary to expectation, quite impervious.

"(A) It cannot be specially pervious to water, for animals which are brought into pure glycerine shrink only after several hours.

"(B) The permeability for air cannot be so great as has always been thought, otherwise the gas bubbles produced—as described in another part of the paper—which create such high pressure in the body of the creature, must be dissolved again more quickly in the surrounding water after readjustment of the normal pressure.

"(C) It is very extraordinary what small effect the usual narcotizing media, such as orthoform-aethylethane, etc., have on the larvæ.

"(D) It is remarkable that *Corethra* hold out in dirty filthy water after all the other plankton have long been dead.

"(E) Larva placed in 53 p.c. alcohol, Nov. 14, 1913, at 3.50 p.m., sinks to the bottom but moves vigorously—at 4.30 p.m. convulsive quivers—5.0 p.m. motionless—heart and intestine not moving. Animal now brought into water, Nov. 15, 9.20 a.m.—vigorous convulsive movements of the muscles, intestine moves feebly. Nov. 17—completely recovers—lived until Jan. 1914.

"(F) Intra-vitam staining is almost impossible. Employing a strong solution of methylin blue—only the middle part of the intestine and the onocytes took the colour."

T. Charters White (♂) also points out:—"Osmic acid of  $\frac{1}{2}$  p.c. strength does not seem to affect it injuriously; even acetic acid largely diluted in water does not seem to act prejudicially to an existence extending over some hours."

We have kept the larva in boiled water contained in a sealed bottle for one month. It was fed once only during that period by transferring it to fresh pond water containing a supply of *Chydorus sphericus*.

Dr. Keilin has located ten pairs of vestigial spiracles, and he says none of them is in any way functional.

We cannot ignore this evidence as to the possibility of the coat being impervious, which, if definitely established, excludes the suggestion of the integument acting as a respiratory organ. At the same time it opens up the question as to the methods employed by the larva in obtaining its supply of air.

Both Dr. Minert and Frankenberg have remarked on the rapid filling of the air sacs and tracheal system with air, within a few minutes after hatching of the larva.

Frankenberg's experiments on newly-hatched larvæ are most interesting. Shortly reviewed they are as follows:—

Immediately on leaving the egg neither the four sacs, or tracheal tubes connecting them, contain air, but are filled with a fluid which is somewhat more highly refractive than water. The ultimate filling of the sacs with air usually takes place in five minutes from release from the egg. The caudal ends of the tracheal tubes and posterior sacs fill first, the air can then be seen to shoot forward into the main tracheal stem from the tenth to the third segments. The thoracic sacs then fill. Almost immediately the air disappears, apparently absorbed by the blood.

He then proceeds to carry out the following simple experiments:—

*Head Cut Off shortly before Filling.*—Immediately the posterior sacs fill, then the thoracic pair, in the normal manner throughout.

*Larva Cut in Half in the Middle.*—Shortly after, a regular filling of the posterior sacs; the thoracic remain empty. This experiment was repeated with the same result.

*Body Cut Through close behind the Posterior Sacs.*—Neither the posterior nor anterior filled.

One cannot help but admit some kind of gas glands which must lie in the eleventh segment.

The morphological examination shows nothing more advanced than a network of globular cells which accompany the tracheal main stem a short distance. The larva being confined in water under a cover-glass, it has no means of communication with atmospheric air.

According to these experiments, an active secretion of gas cannot be doubted.

Frankenberg's paper (10) is in German, and consists of ninety-five pages, from which we have taken a few extracts contained in some rough translations of portions of his important communication. We are, therefore, not able to draw so fully from his paper as we should have liked.

We have seen that the newly-hatched *Corethra* has been able to fill its sacs under a cover-glass in an apparently limited amount of water. We cannot do better than refer to Arber's statement as

to the amount of air held in solution in water, indicating that a large volume of water has to be dealt with to obtain a limited supply of air.

"It is true that dissolved air is richer in oxygen than atmospheric air, about one-third of its volume consisting of this element, but the essential point to bear in mind is that the *total volume* of air held in solution in water at ordinary temperatures is so exceedingly small that in a litre of water the maximum amount of oxygen present is 10 cc.m., as compared with more than 200 cc.m. in a litre of atmospheric air." (Regnard P., 1891.)

If the young larvæ can be confined in a strictly limited amount of water, under a cover-glass, and not in contact with atmospheric air, the evidence is conclusive that it is itself a gas producer from its earliest stage, and the question naturally arises as to its remaining such during the whole of its larval existence.

Our first examination of the air sacs, dissected out from the larva, disclosed the difference in the attachments at the two ends, one showing only a tracheal tube, the other a knob-shaped valve—already referred to. What is the purpose of this difference?

Repeated dissections, and taking out of the thoracic sacs, resulted in repeated failures to obtain more than very short lengths of the tracheal tube, or the tube attached to the valve, the closely packed muscles and other tissues tearing the tubes away whilst attempting to disengage the sacs.

We ultimately tried the posterior pair, and finally succeeded in disentangling the two sacs with long transparent tubes attached to the valve ends. All four sacs are similarly equipped. We cannot say whether the tubes as extracted are complete, or whether some portions were detached in withdrawing them.

The figure we give exactly represents the pair of tubes and sacs as displayed after dissection (fig. 32).

The entire length of each tube is filled with cells, each having a clearly defined nucleus, and some of them appear to be vacuolated, the interstices between the cells being occupied by highly refractive granules. With some diffidence we put forward the hypothesis that the cells in these tubes are mainly responsible for secreting gas for the sacs, the latter containing both nitrogen and oxygen. This indicates two kinds of cells possessing the power of selection, similar to the cells in the mammalian kidney. On the other hand, the cells may secrete nitrogen only, the pigment spots on the air sacs helping in the process of respiration—as hinted by Miall, but he does not suggest how this could be brought about.

We fail to see under these latter conditions how the proportions of the two gases could be maintained; also it implies the sac is pervious to air, its collection and distribution taking place

through the sac walls, in which case it is difficult to understand how the capillary tracheæ can be employed at any period of the larval existence.

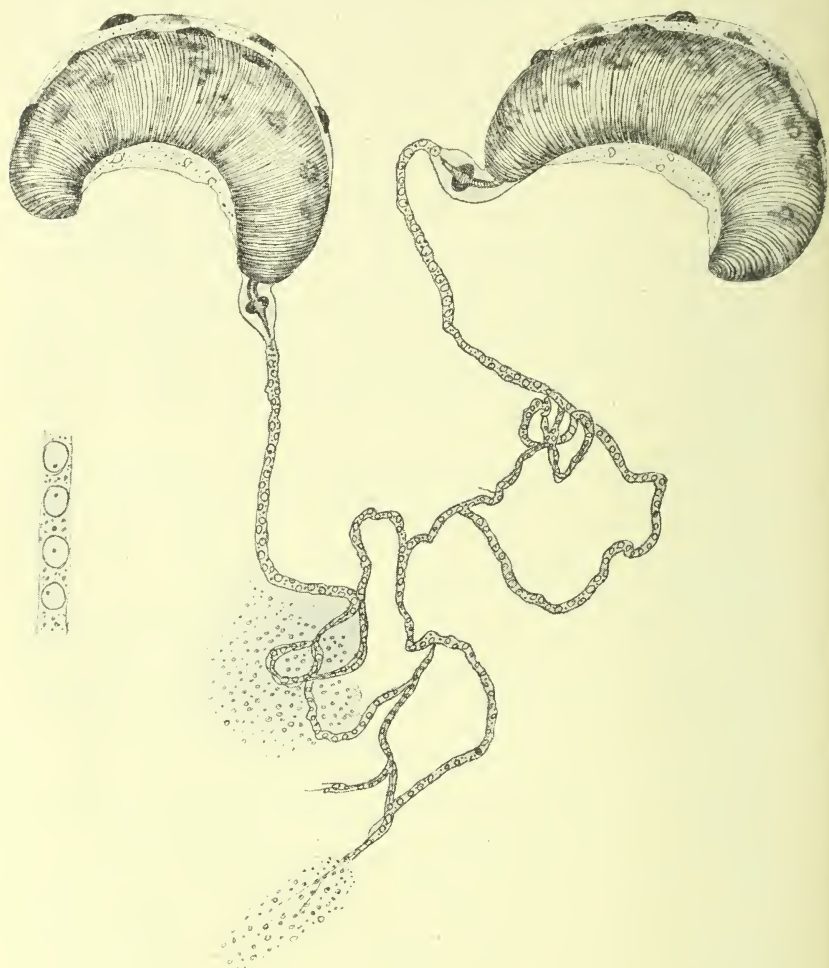


FIG. 32.—Tubes attached to valve ends of pair of posterior sacs, with detail showing cells and granular bodies disposed in between them. The tracheal tubes have been torn off the free end during dissection.

An alternative hypothesis has been advanced (Frankenberg) that the entire gas is drawn from the blood and passes into the sacs. The necessary expansion of the bladder wall to take up the gas is due to the wall having strongly hygroscopic properties,

which swell on taking up water, the swelling probably being assisted by a hypothetical substance discharged into the blood.

Assuming the gas is secreted by the cells as suggested, its collection and distribution would follow on the lines already indicated.

With the descent of the larva, the sacs being non-compressible, diminution of pressure inside the sacs follows, due to the difference of hydrostatic pressure between the inside of the sac and the surrounding fluid. With these conditions an immediate equilization would take place by the available gas passing from the tubes through the one-way valve into the sac.

On ascending we have a reversal of conditions—an increased pressure inside the sac, and diminished pressure outside. The natural outlet for the gas would be through the tracheæ attached to the sac. The two actions, respiration and stabilization, synchronize.

We have satisfied ourselves there is a proper connexion between the sac and capillary tracheæ by discharging the entire air contents of the sac through a short length of tracheæ still intact. We are also of the opinion there exists some check action to prevent air being rushed out of the sac by sudden excessive pressure.

Repeated experiments on air sacs in a live box, to which pressure can be applied, has disclosed the fact that the contained air, when the sac is gently pressed, will issue forth from the tracheal tube end in a series of intermittent bubbles, an appreciable period elapsing between their appearances.

On the other hand, if there was no check we would expect the air to issue forth in a continuous stream.

It has been observed that no air escapes from the broken end of the tracheal tube attached to the sac, when the latter is under observation in a live box, without pressure.

Here we have a condition where pressure inside and outside the sac has been equalized, and the contained air would, therefore, remain in the sac and trachea.

We have referred to the valve as a one-way valve. It is conceivable the small circular bodies in the *tube passing through its centre*, as already described, act as the round glass stoppers used in mineral water bottles, allowing the fluid and gas to pass in, but resisting any escape. The entire body of the knob-shaped appendage is full of gas (fig. 27), being in direct communication with the sac, and arising from its neck is an outlet capillary trachea, part of which spreads over the surface of the sac itself. Correctly termed, this knob-shaped appendage, or valve, acts as an intake as well as an outlet valve.

About the period of completion of the transition stage from larva to pupa, the main tracheal tubes of the pupa can be seen forming at the valve end of the sac; the now shrivelled tubes are

inside the newly-formed pupa trachea, which is built up around them (fig. 33). There is no gas at this stage in the trachea; the refractive index of the body fluid and interior is the same. In fact, it is difficult to see how the trachea could be formed without the body fluid being locked in. The collapsed tubes are also minus any cells, presumably having exhausted themselves in the supreme effort of secreting all the available gas for the enlarged larval sacs, which we have seen increase considerably prior to pupation. The tubes ultimately dissolve out; no trace of them is observable in the final stages.

Our observations concerning the air sacs and trachea have been made on fully-developed specimens, in which the trachea have been clearly defined, and the optical appearance of the latter is that of a tube filled with air and surrounded by fluid of higher

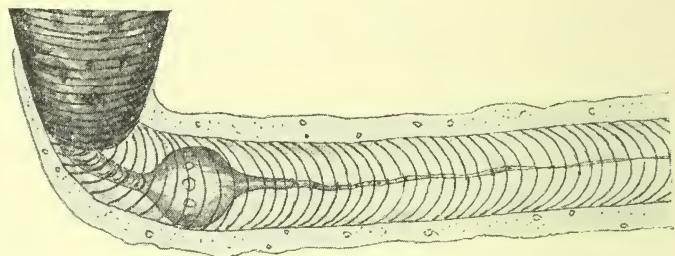


FIG. 33.—Main pupal tracheal tube arising from valve end of one of the posterior air sacs during transition from the larva to pupa. Note the shrivelled inner tube.

refractive index, viz. by transmitted light—bright along the central portion, and dark at the sides. With dark-ground illumination they shine like burnished gold. With the trachea empty of air, no such effects are obtained. The capillary trachea is extremely delicate, and has entirely disappeared in our mounted specimens. Some are in fluid; one in Canada balsam.

We were considerably handicapped during 1921 for supplies of *Corethra* owing to the drought. Through the kindness of Lieut. Damant (12) a batch of about 150 was sent us. Thirty of these were consigned to a glass tank 4 in. by 5½ in. by 1¼ in., and not quite filled with pond water, which contained only a few cyclops, no other food being available.

After a period of two weeks had elapsed we noticed some of the creatures had sunk to the bottom. By a vigorous movement of the body they were able to rise a short distance, immediately sinking again. On examination we found all four air sacs had

collapsed (Pl. XIX., fig. 34), resulting in loss of buoyancy. So far as we were able to keep record, they all suffered from total or partially collapsed air sacs, the last lot sinking about six weeks after being placed in the tank.

The cause of this condition of the sacs is obscure. Disease due to overcrowding may be the reason, but this is doubtful, as we were able to restore some of the sacs to their normal condition, permitting the larvæ to float. The method of restoration was not under complete control. No satisfactory deductions could, therefore, be made; but we believe if the undermentioned experiment could be repeated with care, it might be possible to establish whether the restoration of the air sacs was due to proper supplies of oxygen, or food. If the latter only, then we have some evidence in support of the hypothesis that *Corethra* is a gas-producer, both the collapse of the sacs referred to and absence of gas being due to impoverishment.

#### EXPERIMENT.

Square glass jar,  $2\frac{3}{4}$  in. by  $2\frac{3}{4}$  in. by  $3\frac{1}{2}$  in., containing pond water which had been in the house some few weeks; *Fontinalis* and *Lemna trisulca* in healthy condition and growing. Water in jar filtered through fine bolting silk, pond weed washed and returned to the jar. We could detect no living organisms in the water likely to be of food value to the larvæ. In this jar was placed four larvæ we term sinkers—buoyancy destroyed, air sacs having collapsed.

One larva floating head up; posterior pair of sacs only collapsed.

One larva floating tail up; thoracic pair of sacs collapsed.

In all six *Corethra*.

The body weight of the two floating creatures being supported by two sacs only, these latter had permanently expanded in a manner somewhat similar to the expanded sacs which exist prior to pupation.

January 14, 1922. These six larvæ were placed in the jar containing the filtered pond water, plus the *Fontinalis* and *Lemna trisulca*. During fourteen days, up to and including the night of January 27, no apparent change had taken place in the sacs of the larvæ—that is, the four sinkers remained resting on the bottom of the jar; the one with its tail up still floated; the remaining larva with its head up had died.

On January 28 the five live larvæ were transferred to fresh pond water which was swarming with rotifers (*Brachionus urceolaria*). On February 6 three of the five had recovered and were floating.

We examined one—the air sacs were small, the digestive track

somewhat shrivelled, and very little in it. Another specimen had only three of the sacs restored; one of the posterior pair still collapsed.

We were not able to repeat this experiment, at the time of completing these notes, owing to lack of supplies of larvæ.

The extraordinary vitality of this creature has frequently been commented on, and we will bring our remarks to a close by referring to the behaviour of a *Corethra* which was crushed in a live box. We were observing it under dark-ground illumination, the muscles appearing clear and translucent. At the moment of death a change took place, and they became semi-opaque and iridescent, the alteration taking place quickly through the whole muscular structure. Peristalsis commenced, indicated by a bulbous expansion at one end of a muscle, which ring-like swelling travelled its entire length, expiring at the end, this action repeating itself on the same muscle in the reverse direction. Occasionally two impulses commenced, one on each end of the same muscle. The "expansions" slowly approached; when in contact they merged, and the swelling subsided.

These movements, together with the pulsation of the dorsal vessel, had not ceased after a period of eleven hours.

#### SUMMARY.

1. The variety of hairs, including those on the three pairs of sensory organs, or vestigial legs, on the thorax, are of greater importance as a means of detecting and locating moving objects than the large compound eyes.

2. The vestigial legs and ten pairs of vestigial spiracles supply confirming evidence, if that were necessary, that this larva was at one time a terrestrial form. The double row of minute, and two large, hooks tucked away in a pocket on the ventral side of the anal segment is an obsolete retractile hooked foot, used during its terrestrial existence.

3. Owing to the nature and construction of the four air sacs they are non-compressible.

4. Respiration takes place during the up-and-down movement of the larva, these movements bringing about a diminution or increase of pressure inside the sacs, causing a flowing in or out of the gas.

5. There is very strong evidence of the integument being impervious to air or water; the necessary gas for respiration is probably secreted by the cells contained in the tubes arising from the valve ends of the four air sacs.

6. Miall suggests that the pigment spots may assist in the act of respiration. It is significant that these spots are crowded

together on the dorsal side of the sac only. In this position they receive the maximum amount of light.

7. Experimental work carried out on larvæ with collapsed air sacs, data not sufficiently definite to decide the hypothesis that *Corethra* larvæ are gas producers. This may be proved by further experiments.

\* \* \* \* \*

The foregoing notes have accumulated during the last six years, and are the outcome of observations due to a general interest in *Corethra* larvæ rather than definite work undertaken to establish a particular theory.

To enjoy the pleasure of any interesting developments likely to arise whilst attempting to unravel problems presented in this or any other aquatic larvæ, it is desirable to leave the literature on the subject aside. If necessary, this can be taken up when observations and notes have been completed, and a further pleasure experienced when comparison takes place, differences noted, or maybe agreement on points made, with results of investigation already recorded by other workers.

Confirmation surely has its value as well as novelty in hypothesis.

All the drawings we have made are freehand, the camera lucida not being employed. The value of making such records in assisting to understand structure must be experienced to be appreciated. On the other hand, these, as far as possible, have been supported by micro-photographs.

We have mainly relied on Mr. Caffyn for the photographs of our mounts, and his enthusiasm in carrying out the work has been the means of securing many exceedingly interesting records. Some of these appear with this paper.

Both Mr. Marchmont and Mr. E. J. Sheppard prepared some very useful transverse sections of the air sacs; but, to complete our detailed description of structure of these organs, we were dependent on a full range of transverse and longitudinal sections which Dr. Murray had prepared for us in his laboratory, and we are indebted to him for the interest taken in seeing them through.

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## XVI.—NEW APPARATUS AND METHODS FOR THE DISSECTION AND INJECTION OF LIVING CELLS.

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(*Read October 18, 1922.*)

SEVEN TEXT-FIGURES.

### 1. INTRODUCTION.

OPERATIVE work on the living cell has long been the aim of investigators in cytology and in experimental embryology.

It was not, however, till Barber developed his method that any serious attempt could be made to dissect cells under magnifications high enough to enable one to observe in detail the various steps of the operation. The big feature of his method, aside from the making of needles and pipettes stiff and yet fine enough to puncture red-blood corpuscles, consists in his moist chamber, which allows the needle tips to be operated in a drop hanging from a coverslip in the moist chamber. This method eliminates all interference between the objective and the coverslip, thereby permitting the use of the highest-powered objectives. Unfortunately his instrument for manipulating the needles, unless very skilfully made, has too much lost motion, and wear and tear soon renders the movements jerky and undependable.

Barber uses his apparatus principally for the isolation of bacteria. In 1912 Kite (Kite and Chambers, 1912) applied Barber's method to cytological investigation. The difficulty of handling Barber's apparatus limited the number of investigators in this field, and as the work in micro-dissection progressed the need of a more accurate and simple instrument became imperative.

The instrument described in this paper, a preliminary account of which has been published (1921), is a simplified modification of one which I have been using for two years. It has the following advantages over any instrument hitherto made: (*a*) simplicity of construction; (*b*) absence of any lost motion, no matter how long the device is used; (*c*) accurate and continuous control of the needle or pipette tip in any direction under the highest magnifications of the microscope; (*d*) maintenance of the needle tip in one plane while it is being moved back and forth in any of the three directions; and (*e*) inclusion of adjusting devices which facilitate placing the needle or pipette into position.

The basic principle of the instrument consists in rigid bars which are screwed apart against springs. The movements imparted are in arcs of a circle having a radius of about  $2\frac{1}{2}$  in. As the extreme range of movement of the fine adjustments is only 2 mm. (of which only one is necessary) the curvature of the arc is unnoticeable.

The movements performed by the instrument are so accurately controlled that one can readily carry out such delicate operations as puncturing mammalian blood corpuscles, tearing off the sarcolemma of a muscle fibre, drawing out nuclear chromatin strands, and even cutting up the chromosomes of insect germ-cells. The glass needles used for these operations taper rapidly to a point invisible under the oil-immersion objective. With the micro-pipette, the bore of which need be no larger than one micron in diameter, one can either inject substances into or withdraw material from a cell.

For the isolation of bacteria the instrument is not only steadier than Barber's apparatus, but has new features which facilitate greatly the method of procedure. The application of this instrument for bacteriological purposes is more specifically dealt with in the *Journal of Bacteriology* and the *Journal of Infectious Diseases*.

I take this opportunity of expressing my deep obligation to Mr. W. Farnham, mechanic in the Department of Mechanical Engineering in Columbia University, to whose skill and faithful workmanship the practical evolution of the instrument is due. I wish also to express my appreciation to many friends for valuable suggestions. The principle involved in the construction of the micro-manipulation instrument is patented.

## 2. A MECHANICAL MICRO-MANIPULATOR FOR CONTROLLING THE MOVEMENTS OF A MICRO-NEEDLE OR MICRO-PIPETTE IN THE FIELD OF A COMPOUND MICROSCOPE.

The principle of this device is demonstrated on considering the mechanism for the movements in one plane only (fig. 1*b*). This consists of three bars of rigid metal connected at their ends to form a Z-like figure by resilient metal acting as a spring hinge.

By the action of certain screws the bars can be forced apart; on reversing the screws the bars return to their original position owing to the spring action at the end of the bars. By these means are movements may be imparted to the tip of a needle when placed in the proper position.

The needle or any instrument the tip of which is to be manipulated is held in a carrier fastened to the free end of a bar A at *x*. The needle is made to extend so that its tip is at the apex of an imaginary triangle at D. In order to obtain two movements at right angles to one another and in the horizontal plane

the tip of the needle must be at the apex D of a right-angled isosceles triangle, the base of which is a straight line joining the centres, E and F, of the two springs holding the three bars A, B and C together. The shank of screw G passes through a large hole in bar C, and is screw-threaded in bar B. Turning it spreads apart bars A and B, and imparts an arc movement to the needle tip at D at right angles to that procured by turning screw H.

The movement in the vertical plane at right angles to the aforementioned movements is produced by screw I (fig. 1a), which is screw-threaded in a rigid vertical bar J, and abuts against a vertical extension K of bar C. The extension K is parallel to the bar J, and is connected to it at its top by means of a solid

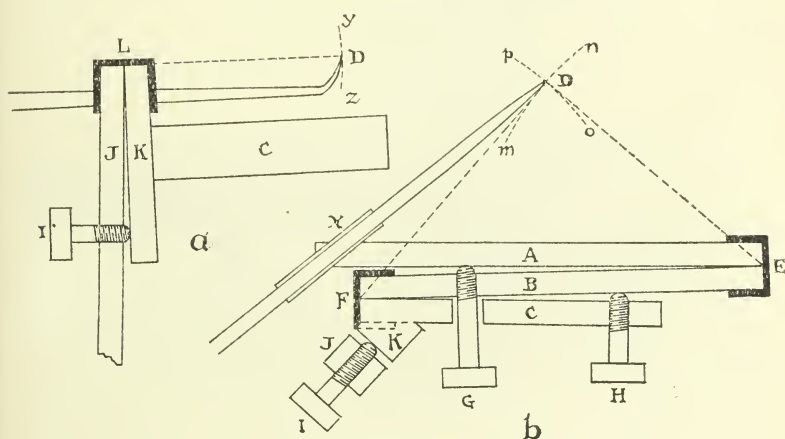


FIG. 1.—Diagram showing the working principle of the micro-manipulator. In 1a, where the instrument is viewed from the side, screw I moves needle tip through vertical arc  $y-z$ . In 1b, where the instrument is viewed from above, screws G and H move the needle tip through the horizontal arcs  $m-n$  and  $o-p$ .

spring hinge. Turning screw I spreads apart bars J and K, and lifts the whole combination (A, B and C) and imparts an arc movement in the vertical plane to the tip of the needle at D. To procure a vertical movement the tip of the needle at D must lie in the same horizontal plane L to D, with the spring fastening K and J together. When screw I is turned the needle tip will then move in an arc  $y$  to  $x$ , more nearly vertical than any other arc on the same circumference of which the point D is the centre.

There are two models of the micro-manipulator. One is fitted with a clamping device with which it can be fastened directly to the front of the microscope stage (fig. 2, cf. fig. 3e). The other is fastened to a rigid pillar rising from a large metal base on which the microscope is clamped (fig. 3a). The horizontal bars of the

instrument extend diagonally across the corner below the level of the stage. They do not interfere with the substage accessories of the microscope, nor with any of the known types of mechanical stages.\*

The first model depends for its steadiness upon the steadiness of the microscope stand.† It is readily adjusted to any square

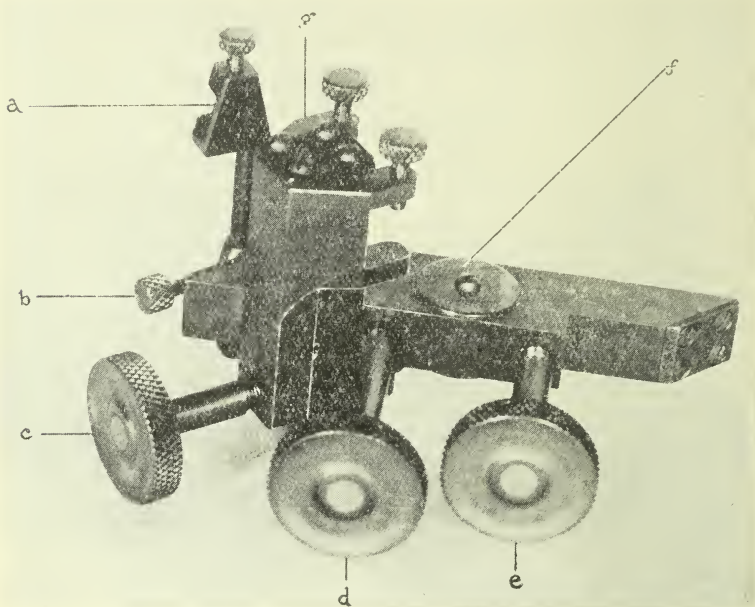


FIG. 2.—Left-handed micro-manipulator to be clamped to microscope stage. *a*, needle carrier with clamping screw; *b*, screw to clamp post of needle carrier; *c*, screw for up and down movement; *d* and *e*, screws for lateral movements; *f*, disc guide for the horizontal bars; *g*, stationary or rigid part of instrument, with lugs by means of which instrument is clamped to microscope stage.

stage, and should prove to be a popular form. The second model is preferable when a microscope with a round stage is to be used. It is also invaluable for micro-injection work where the setting up of the micro-pipette is facilitated by having the microscope temporarily out of the way. Either model may be equipped with both a stage-clamping device and with a pillar, the advantage

\* In the case of the Bausch & Lomb and Spencer stages it may be necessary to replace the screw clamping the front end of the stage for one with a smaller head.

† Steadiness may be assured by a brace, one end being screwed to the rigid vertical part of the instrument, and the other end to the foot of the microscope.

of this being that one may readily change the pillar with its heavy base for the more easily transportable stage-clamping device.

The necessity of having one or two instruments is, of course, conditioned by the type of work to be done. For picking up bacteria one is sufficient. For micro-dissection in experimental embryology a great deal can be done with one instrument, but for cell injection in general and for tissue-cell dissection two instruments are indispensable, so that two needles or a needle and a pipette may be manipulated simultaneously.

When one instrument only is to be used the left-handed form (figs. 2 and 3*e*) is probably the more convenient. For bacteriological work the right-handed form is preferred, as it can be swung around to fit on the left side of the microscope. When a pair is to be used the most convenient combination is a left-handed manipulator which clamps to the microscope stage, and a right-handed one attached to a pillar (fig. 3).

### 3. THE SETTING-UP AND THE WORKING OF THE INSTRUMENT.

Fig. 3 shows two instruments in place ready for work. They should be as close together as possible, so that the open end of the moist chamber need not be too wide to accommodate the needles. This leaves ample room on either side for the attachment of a mechanical stage.

The instrument is provided with means for a preliminary adjustment of the needle in any direction. By these means the needle tip is brought into the field of a low-powered objective. Before centring the tip the bars which control the fine adjustments must be put into a state of tension by giving a few turns to the milled heads of each of the three screws. The needle tip is then more or less accurately centred, and finally raised close to the hanging drop. The instrument is now ready for action.

The milled heads of the screws which control the lateral movements are provided with holes for rods to be used as levers. A most useful accessory is a wire-wound flexible shaft about 2 ft. 6 in. long (fig. 3*e*), with a milled head at one end (fig. 3*a*) and the other end attached to the screw controlling the up and down movement. Curving the shaft around one side of the microscope brings the control of this screw, which is the one most frequently used, close to that of the fine adjustment of the microscope. The shaft also facilitates the use of both hands for the various movements of the one instrument.

Another useful accessory is a brass collar  $1\frac{1}{2}$  in. long (fig. 3<sup>1</sup>) with a spring which projects into its lumen through a slot. The shank of the needle is slipped through the collar and the screw, clamping the spring, tightened sufficiently to enable one to slide

the shaft evenly in the tube. The collar is then clamped into the needle carrier of the instrument. This arrangement facilitates sliding the needle in or out of the moist chamber without danger to the tip of the needle.

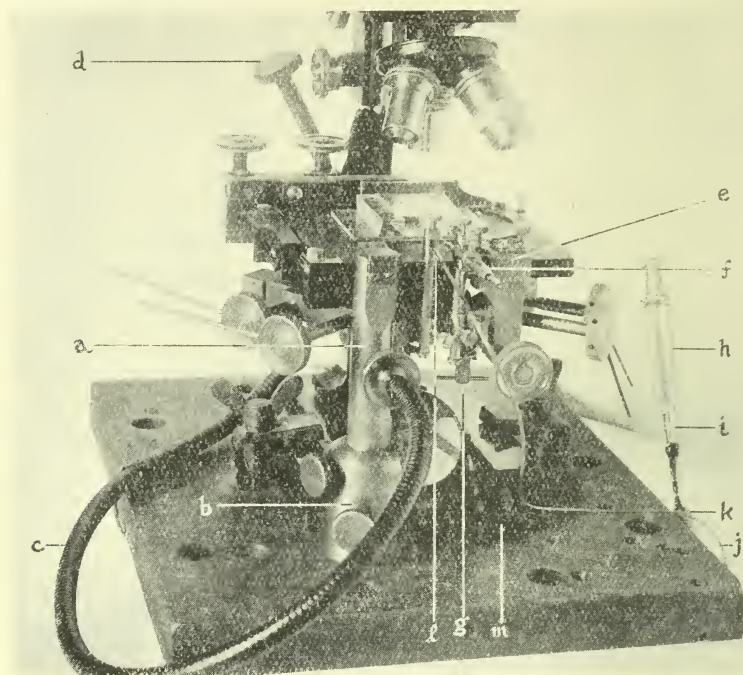


FIG. 3.—Microscope with two micro-manipulators and the micro-injection apparatus in place. *a*, right-handed manipulator on pillar set in collar *b*, fastened to base on which microscope is clamped; *c*, flexible shaft attached to screw for up and down movement, with its milled head at *d*. (Note that screws for lateral movements are controlled by levers.)

*e*, left-handed manipulator clamped to left front of microscope stage. In its needle carrier is clamped brass collar *f*, within which shaft of needle slides. (See detail in fig. 3<sup>1</sup>.) The coarse adjustment for raising and lowering needle carrier is done by screw *g*.

Injection apparatus. *h*, Luer syringe set in its butt *i*, cemented to curved brass tube *j*. This is clamped to base at *k*; its other end is cemented into glass tube *l* (see detail in fig. 3<sup>2</sup>), clamped in needle carrier of the right-handed manipulator *a*.

Most of the holes in the base are unnecessary. Foot of microscope is held by two screw clamps. The adjustable guide *m* keeps microscope in proper alignment.

The micro-manipulator is intended to be used with the mechanical stage of the microscope. The mechanical stage moves the moist chamber (see fig. 3). As the cell or tissue to be dissected lies in

a drop hanging from the roof of the chamber, the motion imparted by the mechanical stage moves the cells against the micro-needle. Indeed, most of the dissection, where a single needle is used, is done by first bringing the needle tip into the cell and then dragging the cell away by means of the mechanical stage.

The horizontal movements of the micro-manipulator are used mostly for the purpose of bringing the tip of the needle accurately into a desired spot in the field of the microscope preparatory to the actual operative work. In order to ensure the greatest possible steadiness to the vertical movement, the part of the instrument which imparts this movement adjoins, and is manipulated from the stationary and rigid part of the instrument. To make this possible the present design incorporates a theoretical error which can be

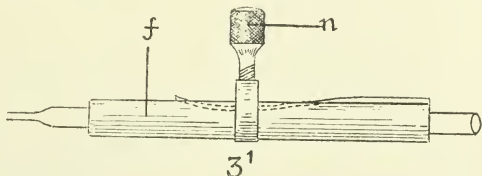


FIG. 3¹.—Detail of brass collar (*f* in fig. 3) which facilitates in and out movement of needle or pipette; *n*, screw which presses on a spring to clamp the needle in the tube.

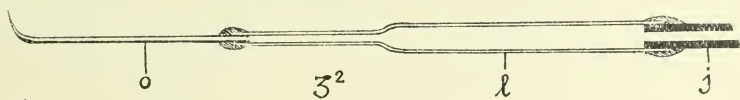


FIG. 3².—Detail of glass tube of injection apparatus (*l* in fig. 3) cemented on brass tube *j*; *o*, shank of micro-pipette sealed into end of glass tube. The pipette can be frequently changed.

understood from fig. 1. Turning screw 1, to produce the vertical movement, throws the combination of bars A, B and C out of the horizontal, and it is these bars upon which the lateral movements of the needle depend. However, the angle at which these bars are placed minimizes the error so as to be practically unnoticeable.

Guides exist in the instrument to ensure a true travel of the bars as they spread apart or come together. The guide for the bar which produces the vertical movement consists of a depression in the stationary part of the instrument into which the vertical bar fits. The guides of the lateral movements are two metal discs which can be tightened or loosened by screws. The upper one is seen in fig. 2, *f*. They correct two possible errors which may occur on reversing the direction of movement, viz. a dropping of the needle or pipette out of focus and a shifting to one side.

The first error can be corrected by tightening one or both of the guides; the second, by loosening them. The guides, therefore, must be neither too tight nor too loose. The first error is the more serious of the two. It is due to an unequal tension in the springs which throws the tip of the moving screw to a different spot on the bar against which it abuts. If this be not corrected, the screw will in time wear a depression in the brass bar on a different part of the bar against which it works, thus perpetuating the error. The second error is due to the guides being too tight, so that they bind and prevent the bars from making a true return. If not corrected, this error will be gradually eliminated with the wear of the frictional surfaces.

#### 4. THE SUBSTAGE CONDENSER AND THE METHOD OF MAKING BARBER'S MOIST CHAMBER AND GLASS NEEDLES.

For critical illumination, the height of the moist chamber must be equal to the working focal distance of the substage condenser. The Abbe condenser can be used by removing the top lens. The focal distance of the remaining lens is almost one inch. In the Bausch and Lomb microscope the substage can easily be arranged to raise this lens sufficiently to have at least half its focal distance above the surface of the stage. This is ample, for one seldom requires a moist chamber as high as  $\frac{1}{2}$  in. The focal distance of this lens can be reduced and its illuminating power correspondingly increased by placing the lens of a 10 X dissecting lens on top of it. This combination has a focal distance of about  $\frac{3}{8}$  in., and, if the substage can be raised to bring the top lens flush with the upper surface of the stage, all of this distance may be used for the height of the moist chamber. Better results are secured with a triple lens condenser with its top lens removed. Such a condenser from Leitz which I am using has a working focal distance of  $\frac{3}{8}$  in. One may also use condensers which are made with a specially long working distance for projection apparatus in which a cooling trough is placed between the condenser and the slide.

If the working focal distance of the condenser be less than  $\frac{3}{8}$  in. it is well to have two moist chambers, one for critical work and the other, from  $\frac{3}{8}$  in. to  $\frac{1}{2}$  in. high, for ordinary work. This is advisable because it is easier to make needles for the higher chamber.

The moist chamber is made of glass. The dimensions of a convenient size are given in fig. 4. The base is a fairly thin glass slide about  $2\frac{3}{8}$  in. by 2 in. in size. The sides consist of strips of plate glass about  $1\frac{7}{8}$  in. long and  $\frac{1}{4}$  in. wide, and of a height determined upon by the available condenser. One end of the chamber is closed with a strip of glass of the same height as the sides, and backed by another strip a fraction higher in order to

prevent a coverslip from sliding beyond it. The trough of the chamber should be from  $\frac{3}{4}$  in. to  $\frac{7}{8}$  in. wide. The strips are cemented with any ordinary glass cement. Heated Canada balsam serves well. Near the closed end of the trough a small strip of glass should be cemented across the trough to provide a well for water. When cementing the long strips to the base care must be taken to have the top surface of the strips horizontal. This may be done, while the cement is still soft, by focusing on the upper surface of the strips and by manipulating the strips until all parts of the surface lie in one focal plane.

The well in the chamber is to be filled with water, and, in order to distribute the moisture throughout the chamber, strips of

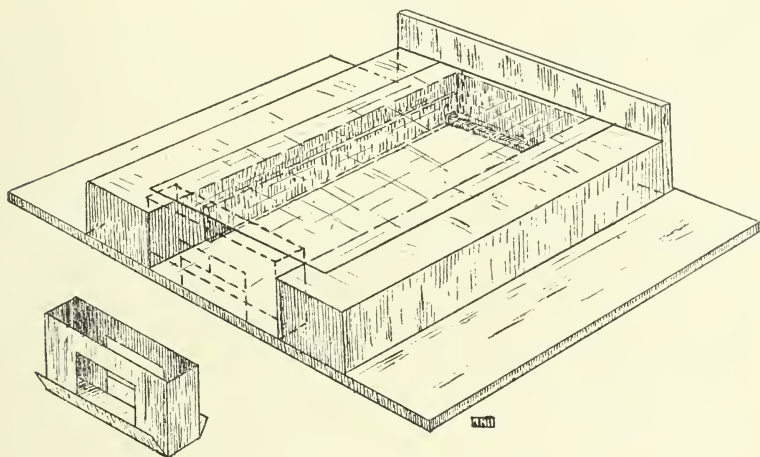


FIG. 4.—Moist chamber and cardboard trough for closing open end of chamber. When the needles are in place (of fig. 3) the trough is placed over shanks of needles (dotted lines at open end of chamber) and filled with vaseline.

blotting paper should be placed along the sides of the trough with the inner end in the water well. Instead of the well one may use cross strips of blotting paper. This moist chamber is designed for coverslips of a size 24 by 40 mm. The coverslip is sealed on the chamber with vaseline. Square coverslips may also be used provided the rest of the chamber be roofed with other strips of cover glass.

The hanging drop containing the cells or tissue to be operated upon is placed on the coverslip, which is then inverted over the moist chamber. To prevent the vaseline from spreading on the cover glass and from contaminating the hanging drop, a thin film of melted paraffin may be spread and cooled on the cover glass bounding the area to be occupied by the hanging drop.

The moist chamber is open at one end to permit the entrance of the micro-needles or pipettes. To prevent undue evaporation, especially when a preparation is to be left overnight, the open end may be temporarily closed by means of a paraffined, thin cardboard trough of a shape in fig. 4. The trough is placed over the shanks of the needles and filled with soft vaseline containing a few threads of cotton to give substance to the vaseline. The vaseline closes around the shafts of the needle and seals the opening of the chamber

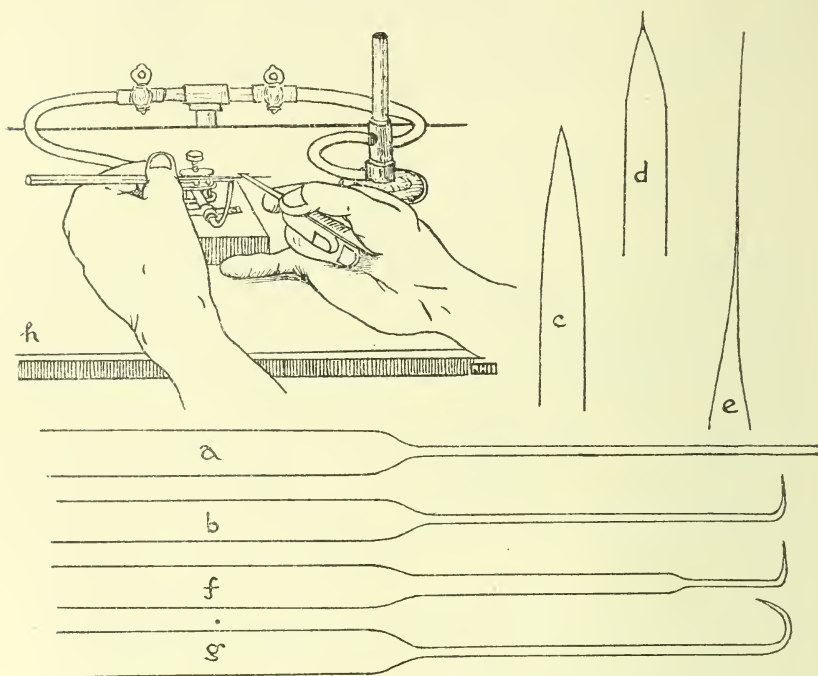


FIG. 5.—Method of making the needles. *h*, position of hands when making needles over micro-burner; *a*, glass tube with capillary; *b*, needle with tip bent up; *c*, a good needle tip; *d*, needle tip serviceable for converting into a pipette; *e*, unserviceable tip drawn out into a hair; *f*, needle with stout shank; *g*, needle with tip bent back for cutting purposes.

without interfering with the movement of the needles. To prevent the vaseline from spreading on the floor of the moist chamber it is well to have a shallow pan of cardboard set under the shanks of the needles for the trough to rest upon.

The needles are made either from soft or hard glass tubing. If a brass tube is to be used to serve as a guide for the in and out movement (cf. fig. 3<sup>1</sup>) the glass tubing should be selected to fit the tube. What I use is a fraction less than  $\frac{1}{8}$  in. in outside diameter.

The thicker the wall of the tubing the firmer tends to be the tip of the needle made from it. The method of making the needle is given in a paper of Barber's (1914), and in one of mine (1918). A brief account will suffice here. Acetylene or ordinary illuminating gas may be used. For a micro-burner use a piece of hard glass tubing bent at right angles, and with the burner end closed except for the smallest aperture that will retain a flame. This may be done by heating the end and pinching it with forceps. The size of the flame may be regulated by a screw pinch-cock on the rubber tube (fig. 5, *h*).

To make the needles proceed as follows:—1. In an ordinary burner draw out one end of a glass tube with a capillary of about 0.3—0.5 mm. in diameter (fig. 5, *a*). 2. Lower the flame of the micro-burner to the smallest flame possible. Now hold the shank of the tube in the left hand and grasp the capillary at its end either with the thumb and finger of the right hand, or with forceps having flat tips coated with Canada balsam. Bring the capillary over the flame and pull gently till the capillary parts. The hands should remain on the table during the process, and, as the capillary parts, lift the glass away from the flame by turning the hands slightly outward. The capillary will separate with a slight tug. The tip should be like that in *c*. If too little heat is used and the pull made too suddenly, the capillary may part with a snap with a broken tip. If too much heat is used the tip is drawn out into a long hair, *e*. 3. Bend the capillary at right angles by heating it just back of the point and pushing up with a dissecting needle, *b*. The length of the needle beyond the bend is conditioned by the height of the moist chamber to be used. The type of needle shown in *g* is used for cutting by bringing the upper limb of the needle below and up into the cell.

#### 5. APPARATUS FOR INJECTION AND FOR THE WITHDRAWAL OF MATERIAL FROM A LIVING CELL.

Barber's mercury pipette method, which depends upon the expansion and contraction of mercury by heat and cold, although excellent, is troublesome to make and easily broken. Taylor (1920) devised an instrument which depends upon a plunger to exert pressure on an enclosed mercury column. With mercury, however, it is difficult to maintain a plunger for any length of time without leakage. I described an apparatus (1921) in which mercury or nujol oil is enclosed in a thin-walled steel cylinder. Pressure on the wall of the cylinder exerts the driving force necessary for injection. This works very well, but it requires special apparatus, and the difficulty of securing a cylinder the walls of which are sufficiently resilient renders the apparatus somewhat unserviceable.

The apparatus shown in fig. 3 does all the work of any device hitherto described, and has the advantage of being extremely simple to make. All that is required is a carefully selected glass Luer syringe of about 2 cc. capacity, a piece of fine brass tubing of about 2 mm. outside diameter and 18 in. long (small, extra soft brass tubing used for lighting purposes is also serviceable), a metal rod 1 in. long with a hole through it large enough to receive the brass tubing, a piece of  $\frac{1}{8}$  in. glass tubing, some de Khotinsky cement or ordinary sealing-wax, and an ordinary small horseshoe clamp.

First seal the metal butt of the Luer syringe to one end of the brass tubing. Slip the metal rod over the tubing and cement it an inch or two away from the syringe attachment. At the other end of the brass tubing seal a short piece of  $\frac{1}{8}$  in. glass tubing, the free end of which has previously been drawn out into a capillary an inch or so long and about one millimetre in inside diameter (fig. 3<sup>2</sup>).

When cementing the brass tube to the syringe attachment and to the glass tube have a wire inserted far into the brass tube before applying the cement. The tip of the brass tube, from which the wire projects, is then coated with cement, and the part to be cemented pulled over it. While the tube is still warm withdraw the wire with a gentle twirling motion. This draws the cement out around the ends of the brass tube on the inner surface of the projecting glass tube, and prevents the formation of pockets in which air may be trapped. In the make-up of the entire system one must exercise care to prevent air from being trapped, for the presence of the air bubbles vitiates the accurate control of pressure in the apparatus.

The brass tube where the metal rod encloses it is to be clamped to the foot of the microscope, or to a base which is rigidly attached to the microscope (fig. 3). The short end of the tube projecting from the rod is bent, so that the syringe, when set into its butt, stands more or less upright. The long end of the tube is carefully curved and bent, so that the glass tube which is sealed on the end will rest in the needle carrier of the micro-manipulator and its capillary project over the stage of the microscope with its end about  $1\frac{1}{2}$  in. from the field of the microscope objective.

The Luer syringe must now be charged with distilled water which has been boiled, and the apparatus filled to within  $\frac{1}{8}$  in. from the tip of the glass capillary. Before stopping, however, it is well to run water through the apparatus for some time to drive out all the air. Before charging the syringe for the last time the plunger should be vaselined or oiled. This much of the apparatus is to be left permanently ready for use.

The micro-pipettes are made from micro-needles drawn out of

thin-walled capillary glass tubing. When finished the shaft of the needle should be at least  $1\frac{1}{2}$  in. long and large enough to fit snugly into the glass capillary of the apparatus. This can be readily done by drawing out a supply of thin-walled glass capillaries and preserving those which fit a sample the size of the capillary of the apparatus. The needle end of the shaft should be bent at an angle the length from the knee of the bend to the tip, depending upon the height of the moist chamber. The shaft of the needle near its end is now thinly coated with de Khotinsky cement or sealing-wax, and, while the cement is still soft, inserted into the glass tube of the apparatus. An extra coat of cement should be added over the joint to ensure the seal. The apparatus is now ready for use. The tip of the needle is brought into a hanging drop of water or a solution, to be injected and converted into a pipette by jamming the tip against the under-surface of the coverslip until it breaks off.\* During the process continual pressure should be exerted on the plunger of the syringe in order to prevent pieces of glass from being sucked into the pipette. Occasionally, while attempting to make the needle in the flame a serviceable pipette results instead. When the pipette is finally in place all or most of the air in it should be driven out.

One can readily see that the sealing of the micro-pipette into the apparatus must be done away from the microscope. It is in this operation that the type of micro-manipulator fastened on a pillar is of advantage. The pipette has to be frequently changed, and it is very convenient to be able to release the microscope from its base by loosening its clamps and to slip it out of the way. As soon as a fresh needle has been inserted the microscope is readily slid back into place. For this purpose the base on which the microscope rests is provided with guides to ensure its true return. When exchanging a pipette care must be taken not to clog the lumen. This can be done by using a minimum amount of cement, and by having the lumen of the tube into which the shaft of the pipette is to be inserted as clean as possible.

The use of thin-walled tubing for making the micro-pipette is to ensure having the largest bore possible at the tip of the pipette. The thickness of the wall and the size of the lumen of the glass tube tend to maintain their original proportions when drawn out in a flame. Often, however, it is more convenient to have pipettes with stouter walls. Such pipettes are less readily broken, but, owing to the smaller sized lumen, run the risk of quickly clogging. The best pipettes are made from hollow needles with a rapidly

\* For placing a hanging drop after the moist chamber has been covered, a convenient pipette is one with its end drawn out into a curved capillary and the tip bent at such an angle so that, on insertion into the moist chamber, the tip will touch the under-surface of the coverslip. With a rubber tube to reach one's mouth a small drop is readily deposited.

tapering tip (fig. 5, *d*), for needles with a long taper are apt to break anywhere.

A necessary precaution is to have the capillary from which the needle is to be made perfectly dry. The presence of the least moisture may result in alternating columns of water and air in the pipette tip which no amount of pressure will expel.

Water seems to be the best medium for transmitting pressure in the apparatus. Mercury is apt to break and allow air or water to leak past it when it reaches the tip of the pipette. When this occurs the separated droplet of mercury clogs the aperture. Mercury also tends to leak past the best plunger made.\* The disadvantage of using water is the risk of its diffusion into the solution to be injected. If a considerable amount of the solution be drawn into the pipette this risk is minimized. A good method is to colour the water (e.g. with Nile blue chlorhydrate or with neutral red). The solution drawn into the pipette from a hanging drop is then visible by contrast. For ordinary purposes a cushion of air between the water and the injection fluid serves well.

Oil is unsuitable because, in spite of all precautions, it occasionally comes into contact with the hanging drop containing the tissue to be operated upon; it then spreads over the surface of the drop and injures the preparation. It also dissolves de Khotinsky cement and sealing-wax, which are so convenient for cementing the pipette to the apparatus.

Manipulation of the syringe is facilitated by fastening it in a frame, and by using a milled screw to press the plunger. I use a microscope for this purpose with the objectives, substage, and mirror removed. The syringe is passed through the centre of the microscope stage, where it is held firmly with a tight-fitting collar of cork. The lower end of the microscope tube rests on the top of the plunger, so that pressure can be brought to bear on it by either the coarse or fine adjustments. There is no need of fastening the plunger to the microscope tube, because the resiliency of the water in the apparatus is sufficient to cause suction in the micro-pipette when the plunger is released from pressure.

#### APPENDIX.

Barber's instrument is based on the principle of a carrier pushed along a groove by a screw at one end. By having a series of three carriers built up on one another, each travelling in a different direction, movements in any one of three dimensions may be imparted to a needle clamped to the top carrier. Hecker (1916) improved Barber's instrument, but added materially to the intricacy of its manufacture.

\* Leakage in the syringe can be avoided by placing a cushion of oil between the plunger and the mercury. This may also be done when water is used.

Other investigators that I know of who have devised instruments for micro-operative work are Schmidt (1869, 1870), Birge (1882), Chabry (1887), Schouten (1905, 1911), Tchahotine (1912-1921), McClendon (1907), Malone (1918), Bishop and Tharaldsen (1921).

Schmidt's instrument is one of historic interest only. I have already described it (1918). Chabry used a delicate spring device with which he could shoot the tip of a glass needle into an ovum to any desired depth. Schouten uses his for the isolation of bacteria. It consists of a pillar carrying a needle which may be mechanically raised and lowered. For the horizontal movements Schouten depends upon pushing the microscope on its base. McClendon attached an up and down movement to a Spencer mechanical stage. Tchahotine used a mechanism attached to the tube of his microscope from which extended a glass needle curved in such a way as to bring its tip into the field of a low-power objective where it was brought into focus. Dissections of cells are carried out by moving the microscope tube and by pushing the cells against the needle tip by means of the mechanical stage of the microscope. Malone uses Schouten's method, but, instead of having a special pillar with a raising device, he mounts his pipette carrier on the tube of a second microscope, whose adjustments serve as a means for raising and lowering the pipette. Bishop and Tharaldsen have a simple instrument based on a principle somewhat resembling mine, but lacking in proper control for one of the two lateral movements.

Recently I have heard that Zeiss is manufacturing a micro-dissection instrument, which, however, is said to be of an intricate design.

Tchahotine and Bovie have recently devised a method for producing localized injury to a cell by means of ultra-violet rays. The method is very ingenious, but, of course, is rather limited in its application to micro-dissection.

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# XVII.—THE PHOTOMETRY OF A BULL'S-EYE LENS FOR ILLUMINATING MICROSCOPIC OBJECTS.

By CONRAD BECK, C.B.E., F.R.M.S.

(Read April 19, 1922.)

FIVE TEXT-FIGURES.

THE bull's-eye first used to increase the illumination of opaque objects has since been employed in connexion with substage condensers and dark-ground illuminators.

The term bull's-eye is here understood to mean a powerful convex lens used for the purpose of condensing light to a focus, or for collecting it from a point source and rendering it parallel. Those used with the microscope are generally between  $2\frac{1}{2}$  in. and  $3\frac{1}{2}$  in. in focal length, and of a diameter only slightly less than their focal length.

The method by which they concentrate light upon an object cannot be properly explained by the ordinary optical text-book diagrams which illustrate the passage of light through a lens. Such diagrams show the light as a point, and illustrate what happens to the light which emerges from that point as it passes through the lens; but a light, except in the case of a distant star, is never a point, but an area of a definite and often a considerable size.

Fig. 1 shows the ordinary text-book illustrations in which O is a point source of light, and S is a screen illuminated by the light at (a) without a bull's-eye; at (b), where the bull's-eye is so placed as to give out so-called parallel light; at (c) and (d) in the two positions where it can be placed in order to focus the light to a point on the screen. Such diagrams are misleading. It would appear that the condition at (c) would produce most light, because as compared with (d) it collects a larger angle of light from the source and brings it all to a point on the screen, but this is not correct.

The size of the source of light must be considered, and if a new set of diagrams are drawn in which not only the light from the central point but that from a point at each extreme edge of the source is shown, the size of the picture of the source of light which

is thrown upon the screen will be ascertained, and a more correct idea will be obtained of what is happening.

Fig. 2 (*b*) shows that the so-called parallel light emitted by a condenser when the light is in its focus, as shown in fig. 1 (*b*), is far from being parallel if the light source has any finite size, and that when it meets the screen it illuminates a large area. In the cases (*c*) and (*d*) in which the light is focussed to form an image of the source, the size of the image is much larger in the case of (*c*) than in that of (*d*), so that although the lens in the case (*c*)

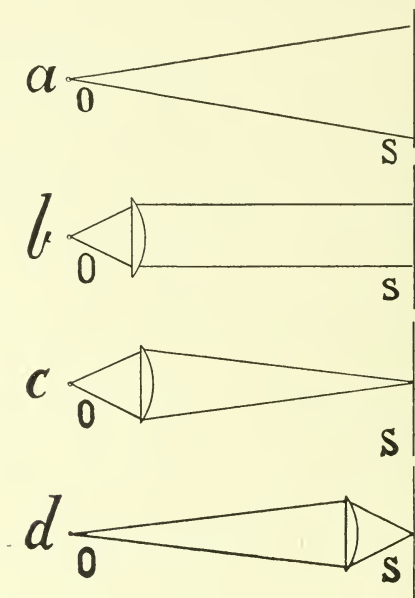


FIG. 1.

collects more light, it spreads it over so much larger an area that the brilliancy on the screen will be far less.

There is no arrangement of lenses or reflectors by which the brightness of a source of light can be increased. All that can be done is to concentrate upon an object a larger number of rays than it would otherwise receive. If daylight falls upon an object in all directions from an unobscured sky, no arrangement of lenses or reflectors can collect more, and, therefore, a bull's-eye will not increase the brightness of an object illuminated by an unobscured sky. It is only of use in daylight in a room into which the light enters from a window which forms a small source of light, where light which would pass into other portions of the room can be

concentrated upon the object. In this case daylight having only an intrinsic brightness of 2 to 4 candle-power per square inch is seldom sufficiently intense to give the brilliancy that is required.

The case will be considered, therefore, of a small brilliant artificial source of light.

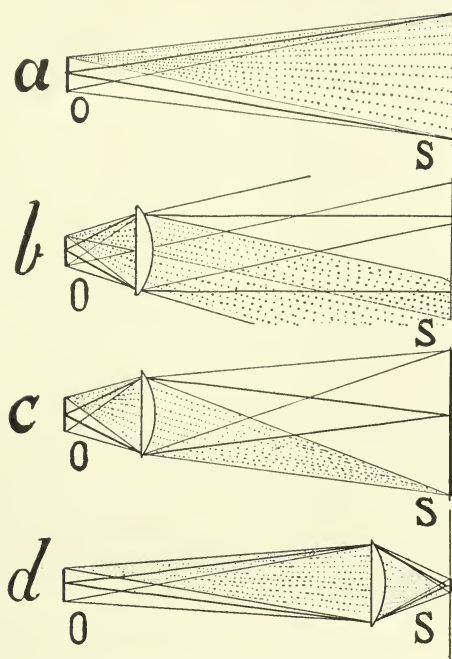


FIG. 2.

Supposing a source of light ( $s$ ) has an area of  $S^2$ . Suppose each unit of light has a brightness of ( $i$ ). A point of light with a brightness of ( $i$ ) will spread out the whole of its light over an imaginary sphere with a radius of curvature equal to the distance ( $d$ ) from the light point to the object. The area of this sphere is  $4 \pi d^2$ , and the light received per unit area of the sphere from each point of a source of light is

$$\frac{i}{4 \pi d^2}$$

or from the total area of the source of light

$$\frac{i}{4 \pi} \frac{S^2}{d^2}.$$

The expression  $\frac{i}{4\pi}$  will be the same in all the investigations, and may be called  $K$ , in which case the illumination received per unit area is

$$\frac{K S^2}{d^2}$$

or by an object (O)

$$\frac{K S^2 O^2}{d^2}.$$

If  $S = 10 \times 10$  mm. = 100 square mm.

$d = 400$  mm.  $d^2 = 160,000$  mm.

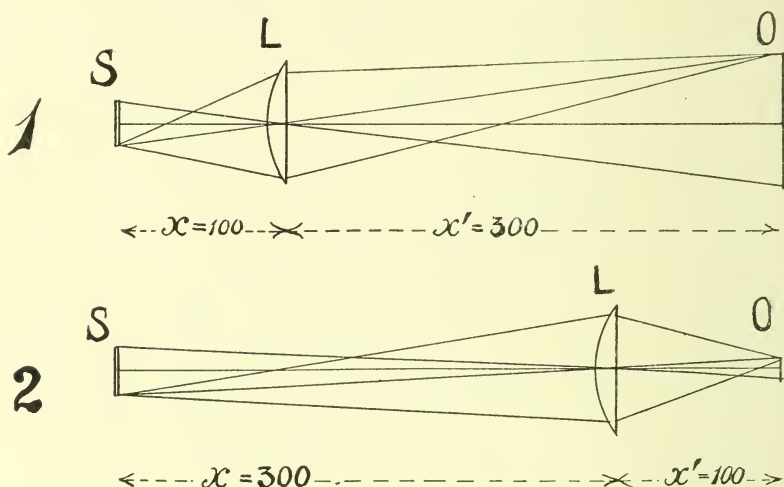


FIG. 3.

Then the illumination received by an object from a source of light is

$$\frac{K 100}{160,000} = \frac{K}{1600} \text{ per unit area}$$

and this forms a basis for comparison when no bull's-eye is used.

Now interpose a bull's-eye between the source of light and the object.

There are two positions for every lens where an image of a source of light can be produced on a screen.

Fig. 3 (1) shows the bull's-eye of a focal length of 75 mm. at a distance  $x = 100$  mm. from the source (S), and  $x' = 300$  mm. from the screen (O).

Fig. 3 (2) shows the bull's-eye at a distance  $x = 300$  mm. from source. The axis of each bundle of light passes through the centre of the lens, and thus from similar triangles the relative diameters of the source and its image are [in Fig. 3 (1)] 1 to 3 and [Fig. 3 (2)] 1 to  $1/3$ .

These are the two positions—namely, when the lens is at 100 mm. and 300 mm. from the source of light—where with a lens of 75 mm. focal length images can be formed in the given total distance of 400 mm. To ascertain the brilliancy the diameter of the bull's-eye must be considered, and we may take this as  $L = 58$  mm. As the lens is circular its area is 2642 mm., and for convenience we may call this  $L'^2$ .

Firstly, when the bull's-eye is at a distance of 100 mm. from the source of light, it receives from the source a total quantity of light, as if it were the screen in the previous case, of

$$\frac{K S^2 L'^2}{x'^2} = \frac{K 100 \times 2642}{10,000} = 26.42 K.$$

The whole of this light is transferred to the object, but is spread out over an area which is the size of the image of the source of light. The area of this image is  $\frac{S^2 x'^2}{x^2}$ , and the total quantity of light must be divided by this area to obtain the intensity of unit area—namely,

$$\frac{K S^2 L'^2}{x^2} \div \frac{S^2 x'^2}{x^2} = \frac{K L'^2}{x'^2} = \frac{K \cdot 2642}{90,000} = \frac{K}{32}.$$

The formula shows that the brilliancy is only dependent upon the intrinsic brilliancy of the source  $K$ , the area of the bull's-eye  $L'^2$ , and the distance of the bull's-eye from the object  $x'$ . In the case under consideration the brilliancy of the object  $\frac{K}{32}$  is 50 times

as great as when illuminated by the direct beams  $\frac{K}{1600}$ . This may

appear a large increase, but to obtain a correct impression of what is required in a microscope it must be remembered that magnifying power is not reckoned by the increased area of an object, but by the increased length, and an object magnified 7 diameters has an area 49 times as large as the original. Therefore, to obtain sufficiently increased illumination to allow of the use of a microscope magnifying 7 diameters without loss of light, we require 49 times

the illumination per unit area. In this case, therefore, if the illumination is sufficient without a bull's-eye to enable an object to be seen clearly with the naked eye, the use of a bull's-eye in the manner here described allows the object to be equally well seen with a microscope magnifying about 7 diameters.

Secondly, when the bull's-eye is at a distance of 300 mm. from the source of light and 100 mm. from the object, the same formula gives

$$\frac{K L'^2}{x'^2} = \frac{K \cdot 2642}{10,000} = \frac{J}{3 \cdot 8}.$$

Here the brilliancy of the object is increased from  $\frac{J}{1600}$  to  $\frac{J}{3 \cdot 8}$  about 420 times, and will allow of the use of a microscope magnifying about 20 diameters.

A substage condenser of a focal length of 8 mm. used without a bull's-eye produces a sharp image at a distance of 8.16 mm. from the object. If the source of light be as before at a distance of 400 mm. from the object, the substage condenser acts exactly as a bull's-eye, and the illumination becomes

$$\frac{K L'^2}{x'^2} = \frac{K L'^2}{(8 \cdot 16)^2}.$$

We are, however, not illuminating an opaque object scattering light in all directions. We are passing light through a transparent object, and use a microscope object glass which can only receive light of a definite angle from the object. Suppose an object glass to have a focal length of 8 mm. which can only receive light at an angle of 0.5 N.A. or 60°. The substage condenser may be of a larger size than is required to admit 60°, but if so the light that is thrown through the object at a greater angle than this will not be collected by the object glass, and need not be considered; therefore, for the purpose of the investigation the substage condenser may be considered to have a diameter of 8 mm. and an area of 50.26 mm. The light received by the object that will enter the object glass will be

$$\frac{K \cdot 50 \cdot 26}{(8 \cdot 16)^2} \quad \frac{K}{1 \cdot 3}$$

an increase of about 1230.

Now interpose a bull's-eye 75 mm. focal length 58 mm. at 75 mm. from the light.

The bull's-eye will direct beams of parallel light from each point of the source of light upon the substage condenser which

are 58 mm. diameter, but only beams 8 mm. diameter will pass through the substage condenser into the object glass; therefore, the bull's-eye is only employing an aperture of 8 mm., and the useful light received by the bull's-eye will be

$$\frac{K S^2 L'^2}{x^2}.$$

The whole of this light is passed through the object spread out over an area which is the size of the image of the source of light. The area of this image is  $\frac{S^2 x'^2}{x^2}$ , and the intensity of unit area will be as before

$$\frac{K S^2 L'^2}{x^2} \div \frac{S^2 x'^2}{x^2} = \frac{K L'^2}{x'^2} = \frac{K 50 \cdot 26}{8^2} = \frac{K}{1 \cdot 27}.$$

The effect of using a bull's-eye with a substage condenser is quite inconsiderable, and has thus only increased the intensity from  $(8)^2$  to  $(8 \cdot 16)^2$  in the ratio of the slight alteration in the focus of the substage condenser caused by using parallel light instead of light coming from a distance of 392 mm.

What has actually taken place due to the use of a bull's-eye is that the size of the area of the object which is illuminated is larger without loss of illumination. The relative diameters of the image of the source of light in the two cases with and without the use of a bull's-eye are approximately in the ratio of the focal length of the bull's-eye to the distance of the light from the condenser, in this case 75 to 392. The use of the bull's-eye increases the diameter of the illuminated area approximately five times, but does not increase the intensity.

An experiment with a photometric eye-piece shows a small but noticeable decrease in the light due to the loss by reflection at the surfaces, and to the absorption of the bull's-eye, which loss has been neglected in this discussion.

But on applying the theory to the modern form of dark-ground high-power illuminator it does not appear to agree with practice.

The dark-ground illuminator referred to is of the type with two reflecting concentric surfaces. It forms a thoroughly good image of the illuminant, it has a focal length of about 3 mm., and is almost free from aberration, and there is no theoretical reason why it should not behave as any other well-corrected condenser. The following experiments show that it gives a far more intense light with a bull's-eye than when it is used alone:—

*Experiment 1.*—A piece of paper placed in immersion contact with a 3 by 1 slip with cedar-wood oil—

- (a) With dark-ground illuminator alone, gave an intensity 1.
- (b) With dark-ground illuminator and bulls'-eye focussed to give parallel light, intensity 3.45.
- (c) With dark-ground illuminator and bull's-eye focussed to form image  $2\frac{1}{2}$  in. from illuminator, intensity 15.

*Experiment 2.*—A specimen of *Coscinodiscus* mounted in an aqueous solution—

- (a) With dark-ground illuminator alone, intensity 1.
- (b) With dark-ground illuminator and bull's-eye focussed to give parallel light, intensity 3.
- (c) With dark-ground illuminator and bull's-eye focussed to give image  $2\frac{1}{2}$  in. from illuminator, intensity 7.

The increase in intensity is very marked and requires explanation.

The question as to whether this illuminator delivered a larger angular cone upon the object under the different conditions was considered when the image of the light was focussed to a distance only  $2\frac{1}{2}$  in. from the illuminator. It was still about 30 times the focal distance away, the light from it was not far from being parallel compared with the reflecting power of the curves, and it should not affect the optical effect of the apparatus. Careful measurement showed no appreciable increase in the angular size of the cone of light delivered upon the object.

The nature of the image of the illuminant formed by this illuminator did not give any serious distortion.

The question as to whether such an increase in light could be occasioned by reflection from surfaces of the slide, cover glass, object glass, or the object itself, seemed improbable on account of the large amount of such increase, but the following experiments appear to show that such is the case:—

*Experiment 3.*—An isolated malaria parasite which filled a red corpuscle, stained and mounted in balsam, was illuminated by a dark-ground illuminator, and the light intensity reduced by means of a pair of neutral glass wedges until the object was only just visible. The use of a bull's-eye exactly as in Experiments 1 and 2 did not render it more visible.

*Experiment 4.*—A stained anthrax bacillus, mounted in balsam, gave the same result.

*Experiment 5.*—A specimen of stained blood, mounted in balsam, viewed with a low power and put slightly out of focus so as to give a uniform matt surface of light, also gave the same result as Experiment 3.

*Experiment 6.*—A stained section of tissue, mounted in balsam, gave an appreciable increase in brilliancy when the bull's-eye was used, but not as great as in Experiments 1 or 2.

It appeared, therefore, that specimens mounted in balsam,

where the refraction is almost the same as the cover glass and slip, are not increased in brilliancy when a bull's-eye is used, and that such increase must be due to reflection from the cover glass and slip.

That this may be so may be illustrated by the following diagrams.

If, as in fig. 4, the image formed by the illuminator of the source of light is very small, such light as is reflected by the

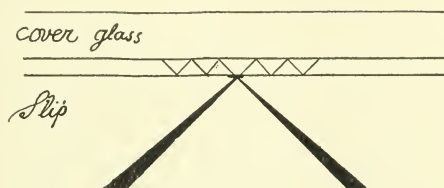


FIG. 4.

cover glass does not come back to the object and increase its brilliancy; but if, as in fig. 5, the image formed by the illuminator is large, then all light from distances  $a$ ,  $b$  and  $c$  from the centre will be partially reflected by the cover glass in such a manner that they fall upon the object in the centre. The effect of the bull's-eye is to produce a large instead of a small image of the source of light

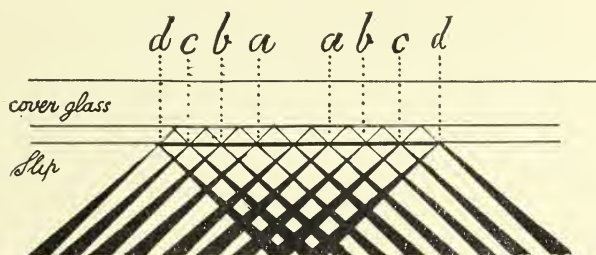


FIG. 5.

on the object, and it would appear that this may be the reason for the increase in light observed in the case of a bull's-eye on such specimens as living bacteria in water. The film is very thin, and many sets of reflections as indicated in fig. 5 might take place.

If an object such as paper, or even a section of tissue, is of itself a diffusing or reflecting material, each particle that is illuminated reflects light in all directions, and it is easy to understand

that the larger the amount of the material that is illuminated, the greater will be the brilliancy of any individual point.

The photometry of bull's-eyes and illuminators may appear in itself to be a matter of small consequence, but the investigation of the dark-ground illuminator points to results as regards reflection and its surprising influence on illumination, that suggest considerations concerning the cause of glare and mistiness in ordinary observation which may lead to important modification in our ideas.

# XVIII.—THE ILLUMINATION OF MICROSCOPE OBJECTS: GLARE AND FLOODING WITH TRANSMITTED LIGHT.

By CONRAD BECK, C.B.E., F.R.M.S.

(Read November 15, 1922.)

EXPERIENCED microscopists are familiar with the effect observed with certain forms of illumination when, although the microscope in use is of the best, the object appears to be covered with a fog or mist, often to such an extent as to obscure the fine detail and sometimes to render the object almost invisible. The following experiment will demonstrate the effect. Examine a diatom with, say, a  $\frac{2}{3}$  in. object glass and a high eye-piece, use a wide angle substage condenser focussed upon the object, and with a flat mirror illuminate the condenser with daylight or light from a piece of illuminated ground glass, not smaller than 2 in. square, placed, say, 3 in. from the mirror. Open the iris diaphragm of the substage condenser to its full aperture, and this appearance of glare or flooding will render a semi-transparent diatom almost invisible.

The same result is observed with a higher power, such as a  $\frac{1}{3}$  in. or  $\frac{1}{6}$  in., the amount of the effect varying according to the details of the illumination.

The cause of this glare is that light enters the eye that has not passed through the object. If a painting is so hung that the glass which covers it reflects the light from a bright window into the observer's eye, he sees but little of the picture, and for the same reason if light enters the microscope that has not passed through the object, the microscopist sees but an indistinct picture of the object.

In order to investigate the subject it is necessary to ascertain the conditions under which the glare occurs. First experiments were made with objects mounted either dry or in styrax or realgar. If such objects are illuminated by a very narrow-angled cone of light, either by the use of a flat mirror alone or by a condenser which is stopped down to a small angle by closing the iris diaphragm, little glare can be seen. The most extreme form of glare will be produced when a substage condenser is used with the iris diaphragm opened to give an illuminating cone of great angle and when the source of illumination is large, as, for instance, daylight or an illuminated ground glass.

If the image of the source of light is very small so that only a small patch in the centre of the field is illuminated, there will be no glare even with the full aperture of the substage condenser.

If it is not small, but a large portion of the object is illuminated, there will be glare, and it will be quite noticeable until the aperture of the condenser is reduced to about three-quarters of the aperture of the object glass, being in some cases perceptible until the diaphragm of the condenser is reduced to even one-third of the object-glass aperture.

For example, using an 8 mm. achromatic object glass 0.5 N.A. with a X50 eye-piece, which gives a field of view of 0.008 in., when the focussed image of a Pointolite on the object is 0.00075 in. diameter there is no glare with a full aperture 1. N.A. in condenser; with the image of the Pointolite 0.00275 in. there is no glare; with image of the Pointolite 0.00675 in. there is considerable glare, reducing resolution; with ground glass giving a very large image, glare is excessive.

In most cases if a ground glass or daylight is not employed the majority of the glare, but not the whole, disappears if the aperture of the condenser is not greater than three-quarters of that of the object glass; and it may safely be said that for objects mounted dry or in styrax or realgar three-quarters of the aperture of the object is the largest useful cone of illumination when a large area of the object is illuminated, but that the whole aperture of the object glass can be advantageously employed if only a small area of the object is illuminated.

Referring to the first experiment with a  $\frac{2}{3}$  in. object glass, with a X25 eye-piece, on such a diatom as *Cymbella Gastraoidea* mounted in styrax, even if no substage condenser be used, but the light from an open sky be thrown upon the object by the concave mirror, a large area of the slide will be illuminated and a glare will make the comparatively coarse markings of this diatom very faint. This glare is entirely removed if a black piece of paper with a fine pinhole be placed immediately under the object, thus reducing the area of the object illuminated without otherwise altering the character of the illumination.

A large number of experiments established the above conditions under which glare is met with—namely:

The larger the cone of illuminating light, the greater the tendency to glare.

The larger the area of the object illuminated, the greater the tendency to glare

Glare due to light entering the observer's eye which has not passed through the object is most likely to arise from reflections.

The microscope has large numbers of lenticular surfaces, from four to twelve in the object glass, and four in the eye-piece; the eye itself has others. The object is mounted on a glass slip with two flat surfaces, and is covered with a cover glass with two other flat surfaces. It is interesting to note that light reflected back from the upper surface of the eye-piece top lens and from the

cornea of the eye can be detected on the surface of an opaque object on the stage of the microscope under suitable conditions, and I devised a series of experiments to ascertain in what manner the majority of the glare was caused.

All the reflecting surfaces are transparent, and the reflection at transparent surfaces is much greater if the light is oblique. If light falls at normal incidence on a glass plate with a refractive index of 1.5, the approximate amount that is reflected at

0° is 4 p.c.	75° is 25 p.c.
45° „ 5 „	85° „ 60 „
60° „ 9 „	

The amount reflected is small when the incidence is direct, but very rapidly increases as the angle goes up beyond 60°. I therefore selected a lens with an aperture of 0.65 N.A. (81°) for the object glass for the following experiments, and a substage condenser with an angle used as an immersion of 1.3 N.A. Used dry it was giving a theoretical 1 N.A., in practice probably about 0.95 N.A. An object glass with a moderate angle was therefore used, and a condenser which would give a much greater angle of illumination if desired.

In a paper which I read on the bull's-eye used in connexion with dark-ground illumination, I pointed out that as much as fifteen times the amount of illumination was sometimes obtained on an object illuminated on a dark ground due to reflections between the cover glass and the slip; and this naturally suggests that if an object seen by transparent light has thrown upon it by this means a large quantity of light from above, or obliquely from the side, the black portions would appear grey, or would even be obliterated altogether.

My first experiment was directed to, ascertain if the front flat surface of the object glass reflects much light down upon the object or the cover glass which again enters the microscope. The diameter of the front surface of the 8 mm. object glass employed is 0.25 in., the central portion only of which is used to transmit the light. I therefore arranged the illumination to produce glare both to an exaggerated extent and also to a slight extent, and placed an opaque stop with an aperture of 0.07 in. over the front of the object glass. This allowed all the light that formed the image to enter the instrument. I could see no difference in the glare in either case whether this stop was used or not, which showed that whatever glare may be caused by this surface is of little consequence, because reducing this reflecting surface to one-fifteenth of its area does not produce any perceptible result.

I then unmounted a dry mount of a diatom *Pleurosigma quadratum*, and examined the glare when the diatom was on a

thin cover glass, first with the cover glass above the diatom, and then with the cover glass below the diatom. In both cases, a ground glass 2 in. square was used, at a distance from the condenser of about 8 in. (focal length of condenser 0.33 in.), and the glare was so great if the aperture was opened even slightly beyond that of the object glass, that all resolution was destroyed. If the ground glass was removed and the Pointolite was almost focussed, full resolution was obtained with the condenser opened to 1 N.A.

I then broke up the cover glass and hunted around the edges of the broken pieces until I found a diatom partly projecting over the edge, hanging in the air so that it had no cover glass above or below it. Then arranging the illumination to give glare, the resolution of the portion hanging in mid-air was perfect and free from glare with the full aperture of the condenser, while the portion of the same diatom which was on the cover glass showed no markings whatever, until by closing the diaphragm of the condenser to about the aperture of the object glass the markings on both parts of the diatom were equally well resolved.

This established the fact that reflection at the cover glass produced glare.

I then took a diatom on a cover glass, and put the lower side of the cover glass in immersion contact with the substage condenser, and found that although there was a very slight glare it was scarcely noticeable; and if the immersion fluid, the front lens of the condenser, and the cover glass had all been of exactly the same refractive index, I do not think any glare whatever would have been visible.

To carry the matter to a more definite conclusion I corrected the achromatic substage condenser so that it was strictly corrected for a slip 0.042 in. thick for a distance of 8 in. To do this I placed a microscopic pinhole 8 in. from the condenser, and set the correction collar of the substage condenser to correct all aberrations. I then placed a small circular opaque spot at 8 in. from the condenser, and focussed a perfect image of this spot upon an object which was mounted on the 0.042 in. thick slip. The image of the black disc, which occupied about one-fifth of the field of view, was very perfect, and showed no shade of greyness round its edges, even if the full aperture of the condenser was used. I then placed a ground glass immediately behind the disc, and examined the effect of glare in rendering the black disc grey, or even white.

The objects selected were on slips that were 0.041 in., 0.0415 in., 0.042 in., 0.0425 in. thick, and the condenser was recorrected for each slip to allow for the above small differences. Three of the objects were diatoms mounted respectively in air, styrax and realgar; the fourth object was a malaria parasite mounted in balsam; and a fifth was a plain  $3 \times 1$  glass slip.

The results were as follows:—

—	Amount of glare 1·3 N.A. aperture in condenser	Aperture of condenser at which glare disappears	Aperture of condenser at which glare lessens considerably	Increase in glare caused by op en- ing aperture of condenser from 0·65 N.A. to 1 N.A.
1. Plain 3 × 1 slip 0·043 in. thick in oil immer- sion contact with conden- ser	Practically none	1·3 N.A.	—	None
2. <i>Pleurosigma angulatum</i> mounted under cover glass in air, slip 0·0425 in. thick, in oil immersion contact with condenser	Marked	0·15 N.A.	0·16 N.A.	Marked
2A. Ditto, not in contact with condenser	Very marked, diatoms appeared illuminated on dark spot	—	0·45 N.A.	Marked
3. Diatoms mounted in realgar in oil contact with condenser	Marked, rather more than 2	0·25 N.A.	0·7 N.A.	Marked
3A. Ditto, not in contact with condenser	Excessive. Black spot almost invisible	0·2 N.A.	0·4 N.A.	Excessive. Rapidly im- proves between 0·6 N.A. and 1 N.A.
4. Diatoms in styrax in oil contact with condenser	Marked. Intermediate between 2 and 3	0·25 N.A.	0·6 N.A.	Marked
4A. Ditto, not in oil contact with con- denser	Very bad. Not quite as bad as 3A, but worse than all others	—	0·35 N.A.	Very great
5. Malaria para- site in balsam in oil contact with con- denser	Very faint, as 1	0·35 N.A.	None	None
5A. Ditto, not in oil contact with con- denser	Faint, more than 5, less than 2	—	0·65 N.A.	Just notice- able

From the foregoing experiments we may conclude that the cause of the majority of glare and flooding, provided the aberrations of the microscope are well corrected, originates from light reflected backwards and forwards either along the  $3 \times 1$  slip, the cover glass, or in the medium between the cover glass and the slip. It may also be increased by reflection between the front of the condenser and the under-surface of the slip. Reflections from the surfaces of the lenses of the microscope do not appear to be sufficient to cause much effect with transmitted light.

We can also gather that little perceptible glare is likely to occur if the object is mounted in Canada balsam, although it can be observed. If the object is mounted dry, in water, styrax or any medium that has not the same refraction as glass, there is great tendency to glare.

The only way in which it can be removed is by illuminating a very small portion of the object if it is desired to fill the whole aperture of the object glass with light.

If it is inconvenient to illuminate a small portion of the object, then the condenser should be stopped down so that it only fills about three-quarters of the aperture of the object glass; but a portion of the resolving power of the object glass is sacrificed. It is best not to illuminate an area of the object glass larger than the field of view at any time.

I am inclined to think that if the corrections of the aberrations of a lens are perfect, and the area of the object is not larger than one-fifth the field of view with a X25 eye-piece, no appreciable glare will be produced whatever the angle of the illumination.

As far as I am aware this subject has not hitherto been investigated, and the above line of research should be carried considerably farther before dogmatic rules of illumination can be drawn up; but until this is done no satisfactory procedure for testing microscope object glasses can be laid down.

The foregoing results suggest that the best method of transparent illumination is to fill the aperture of the object glass with light with a wide angle condenser almost in focus, to cut down to the exact aperture of the object glass and to use something like a point source of light, and that where a large area of field must be illuminated three-quarters only of the aperture of the object should be filled with light and a certain amount of the resolution sacrificed.

When the source of light is exactly in focus the resolution disappears, and the best resolution is obtained when the image of the light is almost but not quite in focus, and the resolution appears to be more brilliant around the margins of the image of the light.

Suggestions have been put forward to explain this which have reference to the phase relationship of the light. The writer has formed the opinion that it is due to some form of glare. His

opinion is based upon experiments with a novel method of illumination largely employed by Sir Herbert Jackson in work on the examination and identification of small particles in various media, notably in glasses and glazes, but he has used it also for the study of a number of other objects, including diatoms. In principle it consists in illuminating the object with plane polarized light, using the full angle of the dry or, in many cases better still, an immersion condenser, and examining the object with the analyser over the eye-piece in the crossed position. The appearance of the field is similar to that obtained with the black-ground illumination, in that the small elements in the objects show up bright on a relatively dark ground. The plane polarized light meets the surfaces of the discontinuities in the object at various angles. It is converted into elliptically polarized light by reflection, and a portion of this elliptically polarized light is then transmitted through the analyser. Each reflecting point in the object is illuminating the portions round about it with this elliptically polarized light, and a completely illuminated object is seen. The light so reflected is somewhat faint, and a powerful source is essential.

In this method, as with dark-ground illumination, whatever resolution is eventually obtained is seen immediately, whereas with transmitted light ultimate resolution is only obtained with infinite care in the manipulation of the light. The explanation is that there is no glare or flooding, while with transmitted light it is probably never entirely eliminated.

Sir Herbert Jackson's method is of such interest that it should receive the careful attention of microscopists.

Mr. Akehurst in July, 1921, put a note in the *English Mechanic* in which he pointed out that certain animalculæ and bacilli showed structure under polarized light, and it was probably due to the same cause.

## XIX.—MONOCHROMATIC ILLUMINATION.

By H. HARTRIDGE, M.D., Sc.D., F.R.M.S., Fellow of King's College, Cambridge.

(Read March 15, 1922.)

## ONE TEXT-FIGURE.

OF the three methods of obtaining monochromatic illumination, viz. (*a*) filters, (*b*) mercury vapour lamp, and (*c*) prism or grating spectroscope, the latter has the advantage of providing light of any required wave-length. It has the disadvantage, however, of requiring special and elaborate apparatus, and this has prevented its use becoming more general. It is the purpose of this paper to describe how an effective but simple monochromatic illuminating apparatus can be constructed. The spectrum-producing part of the apparatus consists of an ordinary celluloid replica diffraction grating which is mounted over and parallel to an ordinary plain silvered mirror similar to, and interchangeable with, the ordinary microscope substage mirror. The surface of the grating may be protected from injury by a piece of plain glass mounted over the top of it.

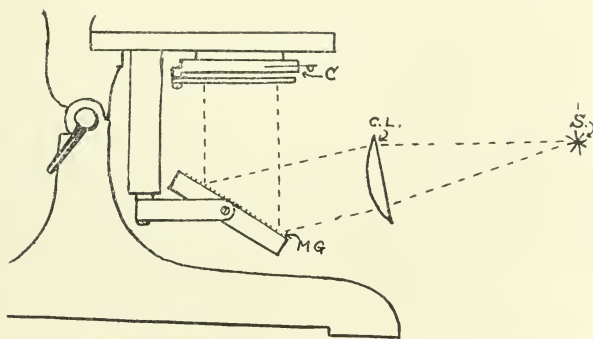
A beam of parallel light incident on this forms the usual sets of first and second order spectra, not only when the light is first incident on the grating, but also after it has suffered reflection and emerges again through the grating. This causes the intensity of the spectra for unit dispersion to be nearly double those produced when a beam passes normally through a replica grating in the usual way.

*Method 1.*—For high powers; the usual substage condenser is used, and is focussed in the plane of the specimen. If the working distance of the condenser is somewhat short a suitable negative spectacle lens of 5 or 6 dioptries focal length may be placed in the stop carrier of the condenser. The special grating mirror is now attached to the tail piece with the grating rulings horizontal, and a beam of parallel light from any suitable source of white light is caused to fall on it. By rotating the mirror about the horizontal axis either the direct beam of white light, or any part of the first order spectrum from red to violet, may be caused to fall on the specimen.

For the spectral light to consist of nearly homogeneous light (light restricted to rays of nearly the same wave-length), and at the same time to illuminate a considerable width of the specimen, the light source should be small in the vertical plane and spread out in the horizontal. I have found that a 1 ampere Nernst filament

is admirable, if a black sheet iron disc be mounted behind it, and a similar sheet of iron with a slit-shaped aperture be mounted in front of it so as to eliminate stray or reflected light. A small carbon arc or a Pointolite lamp may be used if efficiently screened. In the case of the Nernst lamp an ordinary plano-convex spectacle lens of about 8 dioptries focal length is admirable for parallelising the light incident on the mirror. If the Pointolite or carbon arc is used a cylindrical axis vertical of 3 dioptries focal length will be required as well. Further details can be gathered from the diagram below.

The calibration of the apparatus in wave-lengths, which is only required under special circumstances, is, in my opinion, best effected by an ordinary micro-spectroscope eye-piece,\* the wave-length of the monochromatic light being read off directly on its wave-length



C, condenser; MG, mirror with grating; CL, collimating lens; S, source of light.

scale. If such an eye-piece is not available an ordinary direct vision spectroscope with wave-length scale can be used, but it seems that there should be no difficulty in fitting an index arm and scale on to the mirror, and then calibrating it with a standard monochromatic illuminator or with line spectra of suitable chemical elements in the manner employed in the case of an ordinary spectroscope. If the apparatus were manufactured this latter method would be the best one.

When the above arrangement is used for high powers, the field being small is illuminated by practically the same wave-length light all over; particularly is this the case when the condenser is of relatively long focal length. If for special purposes it is required to be able to restrict the illuminated field to an area as small or smaller than that of the eye-piece, then the special method of illumination previously described should be employed,† the grating

\* See Spitta, *Microscopy*, edition I., p. 426.

† Journ. Quekett Micro. Club, Series II, No. 85, 1919.

mirror above described being used to cast a spectrum in the plane of the lower iris.

*Method 2.*—For low-power work with lenses of small N.A., a field illuminated with light of one wave-length of larger diameter is required than the above methods will provide. Good results can often be obtained in these cases without the condenser or with its lower lens only. The spectrum is now formed approximately in the upper focal plane of the objective, and a slit-shaped stop placed there allows only a restricted part of the spectrum to enter the eye-piece.

Theory shows that the spectrum formed by such a mirror-grating is crossed by interference bands. If the grating is mounted on one side of a slab of glass and the under surface of the glass is silvered, the distance between grating and silvered surface is considerable, and the bands are so fine that special methods are required to show their existence. If, however, it is the upper surface of the glass that is silvered, and the grating be mounted direct on the silver surface, the path difference between grating surface and reflector is small, and the interference bands are coarse, in one case being 16 in the first order spectra. This arrangement has one very marked disadvantage, that only 16 parts of the spectrum can be used for illumination; it has, however, the compensatory advantage that the brightness in the centre of the bands is twice as much as that formed by the arrangement giving uniform spectra.

SUMMARY OF CURRENT RESEARCHES  
RELATING TO  
ZOOLOGY AND BOTANY  
(PRINCIPALLY INVERTEBRATA AND CRYPTOGRAMIA),  
MICROSCOPY, ETC.\*

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BOTANY.

(Under the direction of A. B. RENDLE, M.A., D.Sc., F.R.S., F.L.S.)

GENERAL,

Including the Anatomy and Physiology of Seed Plants.

Cytology,

Including Cell-Contents.

**Behaviour of Homologous Chromosomes in *Canna*.**—J. BELLING (*Proc. Nat. Acad. Sci.*, 1921, 7, 197–201, 2 figs.). A study of the behaviour of homologous chromosomes in triploid varieties of *Canna*. Forty-six different species of *Canna* were grown, and most of these were diploid; the pollen-mother-cells showed 9 dyads before the first division, and in the majority of the plants these separated into 9 + 9. One regularly triploid species differed from other *Cannas* with more than 18 single chromosomes in being of smaller size, and in having smaller flowers. In 18 pollen-mother-cells the total number of chromosomes was 27; there were usually 9 triads, each of which divided into 2 and 1 on the spindle, and travelled at random to the 2 poles. A similar arrangement, although less distinct, was found in a triploid *Datura*.

S. GREVES.

**Counting Chromosomes in Pollen.**—J. BELLING (*Amer. Natur.*, 1921, 55, 573–4). A description of a new method of staining which has had very satisfactory results in the study of the different chromosome-numbers in certain mutants and hybrids. "To a quantity of aceto-carminine a trace of a solution of ferric hydrate dissolved in 45 p.c. acetic acid is added until the liquid becomes bluish-red, but no visible precipitate forms. An equal amount of ordinary aceto-carminine is then added. The anthers are teased out with nickel instruments. If the stain is too dark more aceto-carminine is to be supplied. It may be diluted with 45 p.c. acetic." The chromosomes appear most distinctly in the metaphase of the second division, and the preparations will keep a week or more if an excess of stain and of iron are avoided. The cytoplasm remains unstained, while the chromosomes are a deep bluish-red.

S. G.

\* The Society does not hold itself responsible for the views of the authors of the papers abstracted. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, etc., which are either new or have not been previously described in this country.

### Structure and Development.

#### Vegetative.

**Normal and Abnormal Germination of Grass-fruits.**—J. ZINN (*Ann. Rep. Maine Agric. Exp. Stat.*, 1920, Bull. 294, 197–216, 44 figs.). “An account of the processes that take place at the time of emergence of the radicle of hulled grass-fruits from the surrounding tissues.” The penetration of the pericarp is a purely mechanical process due to the pressure of the embryo, whereby the tissues break away at a certain point and usually in a certain direction. Normally the coleorhiza breaks through the base of the fertile glume at a region where the resistance is diminished by modification of the epidermal and hypodermal cells; the latter are pushed apart, the sclerenchymatous elements being entirely uninjured, and the epidermis more or less so, but the fibro-vascular bundles are invariably broken. In abnormal germination external mechanical factors due to artificial conditions hinder the growth of the radicle in the normal direction, and growth takes place in the direction of least resistance. Abnormal germinations are absent or rare when grasses are grown in natural soil, and under normal conditions there is no dying off of the radicle within the glume. The rupture of the glumes by the coleorhiza is due to the turgescence of the latter aided by the short thick walls of its apical tissues. The coleorhiza also acts as a protective organ for the young radicle, and by means of its hairs or trichomes assists in fastening the seedling to the soil. The formation of hairs is a general feature of the coleorhiza of grasses. The radicle itself passes from the coleorhiza through a longitudinal lateral opening, without injuring the cells in any way. S. G.

**Vascular Anatomy of Seedlings of *Phaseolus*.**—J. A. HARRIS, E. W. SINNOTT, J. Y. PENNYPACKER, and G. B. DURHAM (*Amer. Journ. Bot.*, 1921, 2, 63–102, 12 figs.). A comparative and biometric study of the vascular system of dimerous and trimerous seedlings of *Phaseolus vulgaris*. In dimerous seedlings the root is tetrarch with four protoxylem poles, from which arise eight bundles which pass through the hypocotyl to the cotyledonary node, where two strands are given off to each cotyledon, while the remaining six divide to form the typical twelve bundles found in the epicotyl. The trimerous seedlings differ in having six protoxylem poles, twelve bundles in the hypocotyl, nine primary bundles, and fourteen to eighteen permanent bundles in the epicotyl. Both types of seedlings may have additional intercalary bundles in the hypocotyl. The trimerous seedlings show a greater variability in the number of root-poles, but the deviation in the intercalary bundles is more marked in dimerous seedlings. In the central part of the hypocotyl the dimerous seedlings vary more greatly in the number of bundles, while in the epicotyl the reverse is the case. From the above results the authors conclude:—(1) That external differentiation is accompanied by profound differences in internal anatomy; (2) that anatomical characters vary greatly in series of individuals which are genetically highly homogeneous; (3) “that variation in anatomical structure is not constant for the plant as a whole, but may

differ from region to region, or from organ to organ," and furthermore this variation is not constant, but is conditioned by morphological features; (4) that the problems of morphology or of morphogenesis demand the use of biometric and comparative methods to supplement each other.

S. G.

**Correlations in Anatomy in Seedling of Phaseolus.**—J. A. HARRIS, E. W. SINNOTT, J. Y. PENNYPACKER, and G. B. DURHAM (*Amer. Journ. Bot.*, 1921, 8, 339-65). An investigation as to the interrelationship of the vascular structures in the different regions of normal and abnormal seedlings. "The characters considered are:—(1) number of primary double bundles, of intercalary bundles, and of total bundles at the base of the hypocotyl; (2) number of bundles in the central region of the hypocotyl; and (3) number of bundles in the central region of the epicotyl." There is close correlation between the three classes of bundles at the base of the hypocotyl and the number of bundles in the central region of the hypocotyl; this correlation is usually greater in normal than in abnormal plants. It is not possible to assert definitely that any such correlation exists between the three classes of bundles at the base of the hypocotyl and in the central region of the epicotyl. There is little if any correlation between the number of bundles in the centre of the hypocotyl and the centre of the epicotyl. These results confirm those of an earlier paper that the vascular system is completely re-organized at the cotyledonary node. Differentiation of the parent plants resulting from either genetic or environmental factors cannot be regarded as the source of the variation and correlation in the number of bundles. The authors conclude—(1) That the vascular system of the seedling is not constant, but varies both in the species and in the individual; (2) that seedlings differing in external form differ profoundly in their internal anatomy, and the external form is correlated with the internal structure; (3) that the anatomical characters of the seedling are interrelated, but while some show strong correlation, others show little or no correlation. It seems possible that quantitative measurement of such relationships will assist in solving some of the fundamental problems of morphogenesis.

S. G.

## CRYPTOGAMS.

### Pteridophyta.

**Origin of New Varieties of Nephrolepis by Orthogenetic Saltation.**—R. C. BENEDICT (*Amer. Journ. Bot.*, 1922, 9, 140-57, 6 pls.). This second paper treats of the regressive variation or reversion from the primary and secondary sports of *Nephrolepis exaltata* var. *bostoniensis*. For the previous memoir reference should be made to *Bull. Torrey Bot. Club*, 1916, 43, 207-34, 6 pls. In the present paper the following points are discussed:—1. The nature of regressive variation. 2. Description of the regressive varieties (with a genealogical chart). 3. Reversions of the primary sports of *bostoniensis*. 4. Reversions of the secondary sports of *bostoniensis*.

A. GEPP.

**Polypodium virginianum and P. vulgare.**—M. L. FERNALD (*Rhodora*, 1922, **24**, 125–42). A careful investigation of the ferns ascribed to *Polypodium vulgare* and allied species in North America, showing that they may be grouped under two species:—1. *P. virginianum* Linn., which grows on shaded rocks and banks (but rarely on tree-trunks), and ranges from Newfoundland and Manitoba southwards to the mountains of northern Georgia and Alabama, Illinois and eastern Missouri; it varies little. 2. *P. vulgare* Linn., which ranges over Europe and adjacent Asia and north Africa, the Atlantic Islands, and from Alaska to lower California, Arizona and New Mexico. The American forms of *P. vulgare* agree with the European type in having a stout sweetish rhizome with peltately attached scales of similarly dense areolation, similar variability of frond, median sori, and a predilection for growing on living or dead trees. Included in its synonymy are *P. californicum* Kaulf., *P. intermedium* Hook. and Arn., *P. falcatum* Kellogg, *P. Glycyrrhiza* D. C. Eaton, *P. hesperium* Maxon, *P. occidentale* Maxon. The characters of *P. virginianum* are a soft, bitter rhizome, with cordate scales of laxer areolation, but thick-walled cells, narrower fronds, more strictly alternate pinnae, and sori nearly marginal. A. G.

**Studies of Tropical American Ferns.**—WILLIAM R. MAXON (*Contrib. U.S. Nat. Herb. Washington*, 1922, **24**, 33–63, 10 pls.). This paper, the seventh of the series, contains an account of the North American species of the *Alsophila armata* group, with key and descriptions; a singular new *Alsophila* from Panama; notes on *Dicranopteris*; the Jamaican species of *Cheilanthes*; two new species of *Polystichum* from the West Indies; *Atalopteris*, a new genus of Dryopteroid ferns from the West Indies; three new species of *Dryopteris*, of the subgenus *Stigmatopteris*; and some miscellaneous notes. A. G.

**Collection of Pteridophyta from Celebes.**—CARL CHRISTENSEN (*Svensk. Bot. Tidskrift*, 1922, **16**, 88–102, 7 figs.). An account of a collection of 88 Pteridophyta collected in the north, central, and east Celebes by W. Kaudern in 1917–20. Most (75) of them had previously been recorded for Celebes; but 6 were previously unknown there; *Nephrolepis dicksonioides* Christ is a highly interesting endemic species. Of the new species the following are figured:—*Asplenium dicranurum*, *Humata Kaudernii*, *Lomagramma sinuata*, and *Polypodium scalpturatum*. A. G.

#### Bryophyta.

**Male Receptacle and Antheridium of Reboulia hemisphaerica.**—A. W. DUPLER (*Amer. Journ. Bot.*, 1922, **9**, 285–95, pl. and figs.). Having published a recent paper on the origin and structure of the air chambers of *Reboulia*, the author now treats of the male receptacle and antheridium, confirming the recent work of A. W. Haupt in some respects and supplementing it in others. In his summary he states that: 1. The male receptacle of *Reboulia hemisphaerica* occupies a dorsal position, as a rule, posterior to the female receptacle which terminates the branch. 2. The receptacle is usually more or less lunate in outline, although it may be circular, or more or less irregular. It is sessile as a

rule, although in rare cases it may be elevated on a very short stalk. 3. The plant is monoecious, with the sex organs in distinct groups, although bisexual receptacles may occur. 4. The antheridia show a tendency towards centrifugal development. Variations from the usual Marchantiaceous type of development occur, such as the occasional appearance of an apical cell with two cutting faces, and the occasional formation of only two primary spermatogenous cells in a segment. 5. The male receptacle is a plastic structure, probably representing an elementary stage of a branch system, and showing transitions from the "dorsal outgrowth" type to the "composite branch-system" type.

A. GEPP.

**Study of Cephaloziella.**—CH. DOUIN (*Revue Bryologique*, 1914, 83-4). The species of *Cephaloziella* prefer light and air, and mostly are killed by excess of moisture. They are in best condition in October and November, occurring especially in open situations. Often they are found in larger patches of little plants; the explanation of this is to be sought in the multiplication which goes on during the summer. In the spring the spores and propagula germinate; a drought follows, and at once the apical cells are transformed into groups of propagula. These latter in their turn germinate during the next showery period. And so, on and off, the process continues during the summer, a single chance spore or propagule thus giving rise to thousands of plants which rapidly develop on the permanently damp soil of autumn and attain maturity.

A. G.

**Cheilolejeunea hobartiensis.**—WM. HY. PEARSON (*Revue Bryologique*, 1922, 11-13, figs.). A description and figures of this new hepatic from Tasmania. Stephani was in error in referring it to *Strepsilejeunea austrina* Spruce, which is a synonym of *Lejeunea mimosa* Tayl. A. G.

**Two New Hepatics.**—T. HUSNOT (*Revue Bryologique*, 1920, 26-7, figs.). Descriptions and figures of two new French hepatics, *Cephaloziella subglobosa* from Turques in Calvados, and *Lophozia Corbieri* from Magny-le-Désert in Orne. The latter plant has the habit of *L. Limprichtii*.

A. G.

**Abruzzi Hepaticæ.**—ALEXANDER W. EVANS (*Revue Bryologique*, 1920, 57-8). A list of 14 hepatics from the mountains of the Abruzzi, the hepaticology of which is unknown. They were collected at Scanno in the heart of the Abruzzi, at an altitude of about 3500 ft., during a brief visit.

A. G.

**Hepaticæ of Bavaria.**—IGNAZ FAMILER (*Denkschriften Bayer. Bot. Gesell. Regensburg*, 1920, 14, 1-167, 27 pls., and figs.). The first part of this treatise on the Hepaticæ of Bavaria appeared in 1917 and treated of the distribution of the hepatics in Bavaria. The second part is concerned with descriptions of the genera, species and forms. Keys of the genera are supplied, and under each genus is a key to the species. Some of the text-figures contain a surprising amount of minute but clear information in the form of compared outlines of numerous allied species. The plates illustrate the species by nature prints (nat. size), supplemented by photomicrographs magnified either 2-3 diam. or 25-50

diam. The index gives the derivations and meanings of the plant-names, as well as a brief biographical note of everyone whose name is commemorated. A. G.

**Notes on North American Hepaticæ.**—ALEXANDER W. EVANS (*Bryologist*, 1922, 25, 25–33, 1 pl.). In his ninth contribution the author corrects various previous records, reducing some of the species to synonymy, and describes and figures a new species of *Diplophyllum* and the perichaetial bracts and perianth of *Ptychocoleus heterophyllum*; he also confirms the identification of *Gymnomitrium varians* (Lindb.) Schiffn. as a North American species; this hepatic was described by three different authors about forty-three years ago, and has a long synonymy. A. G.

**West Indian Hepaticæ.**—W. H. PEARSON (*Journal of Botany*, 1922, 60, 217–28). An account of the Hepaticæ gathered by Miss E. Armitage in the West Indies, mostly in Dominica, in 1896, and now deposited in the Manchester Museum. They have been through the hands of F. Stephani, with some of whose determinations Pearson disagrees. Three new species are described:—*Odontolejeunea Armitagei*, *Herberta Armitagei*, *Metzgeria Armitagei*; and interesting critical notes are given about *Lejeunea Sieberiana* G., *L. chærophylla* Spruce, and other involved species of *Lejeunea*, as well as of *Herberta*, *Plagioclila* and *Metzgeria*. A. G.

**Hepatics from the Cameroons, West Coast of Africa.**—WILLIAM H. PEARSON (*Mem. Proc. Manchester Lit. and Phil. Soc.*, 1921, 65, No. 1, 6 pp., 2 pls.). An account of some hepatics found among mosses in pockets of earth on logs of ebony brought to Liverpool from the port of Duala in the Cameroons. Six plants were detected, two of which are insufficient for more than generic determination; and two are new to science and are described and figured—*Aneura Travisiana* and *Ceratolejeunea Saxbyi*. The latter was also collected on the Gold Coast by H. H. Saxby. A. G.

**Experiments in the Capacity of Mosses to withstand Desiccation.**—N. MALTA (*Acta Universitatis Latviensis*, 1921, 1, 125–9, 5 figs.; see also *Bryologist*, 1922, 25, 38). Many xerophilous mosses after long years in a herbarium are capable of reviving. Such growth occurs from dormant buds, and results in rhizoids with brood bodies, secondary protonema, or even vegetative shoots. Species of Grimmiaceæ and Orthotrichaceæ retain this power. Of the samples tested most were 1–6 years old, but *Anæctangium compactum* revived after 19 years of desiccation. Spores retain vitality longest; some spores of *Grimmia pulvinata* germinated after being preserved in dryness for nearly 70 years. It is essential that the samples should have been dried naturally. A. G.

**Cellular Index in the Muscineæ.**—J. AMANN (*Revue Bryologique*, 1921, 33–8). A character of great value for distinguishing certain closely allied moss species is the sizes of the cells in the leaf areolation: for example, in *Timmia*, *Rhabdoweisia*, and *Fissilens*. Though of little

or no value in other cases, and though liable to vary with external conditions, yet it is worthy of study. The method suggested is the insertion of a diaphragm in the ocular of the microscope, a rectangular opening (2 mm. square) having been cut in the diaphragm. The actual dimensions of the square field thus obtained are then measured with a stage micrometer. Then, if in this field of  $n$  sq. mm. one can count  $c$  cells in a given moss leaf, the total number of cells in a sq. mm. is the "cellular index,"  $c : n$ . The best method of employment and some necessary precautions are described. Examples are given, and a striking table of the results arising from the application of the method to the species of *Mnium*. A. G.

**Cellular Index of European Fissidens of the Crassipes Group.**—J. AMANN (*Revue Bryologique*, 1921, 65-9). The author applies his cellular index method to six species of *Fissidens* of the *Crassipes* group, and gives the measurements of numerous examples, together with the conclusions which he draws. A. G.

**Observations on Some Species of the Genus Fissidens.**—R. POTIER DE LA VARDE (*Revue Bryologique*, 1914, 85-92, 94-8; 1920, 17, 18, 23-5; 1921, 5-9, 70-2; 1922, 1-5, 4 figs.). Critical notes arranged under the following headings: (1) Preliminary remarks on the specific value of apparent dioccism. (2) *Fissidens tamarindifolius*: is it really a specific type? (3) Remarks on *F. gracilis* (La Pyl.) Brid. (4) Concerning *F. Lylei* Wils. (5) On the presence of *F. Monguilloni* Thér. in Mayenne and in La Manche. (6) Concerning *F. Mildeanus* Schimp. (7) New stations of *F. Monguilloni* Thér. (8) Remarks on No. 158 of the Musci Galliae. (9) *F. crassipes* Wils. var. *Philiberti* Besch. (10) *F. Curnowii* Mitt. in Tunis. A. G.

**Notes on Fissidens serrulatus Brid. and F. polyphyllus Wils.**—G. DISMIER (*Revue Bryologique*, 1920, 54-6). A discussion of the specific value of these two species which have sometimes been regarded as forms of one species. Authors have trusted too much to the character of the leaf—length and breadth, degree of denticulation at the apex, papillosity, presence or absence of a margin, position of inflorescence. But these are unstable; and intermediate forms have been ascribed now to one, now to the other, of the two species, or have been proposed as independent species. However, the two species can be distinguished with ease and certainty in view of the anatomical characters pointed out by Bottini, in *Malpighia*, 1889, 3, 101-19, an interesting paper which is little known to bryologists. A résumé of the specific differential characters is accordingly given by Dismier. They relate to the relative sizes of the cells in a transverse section of the stem, and also of certain cells in the leaf. The distribution of the two species is given. A. G.

**Observations on Didymodon cordatus Jur.**—G. DISMIER (*Revue Bryologique*, 1921, 52-3). This moss was regarded by Limpricht and by Warnstorf as an autonomous species, and by Dixon and by Amann as a sub-species of *D. luridus*; but Dismier is convinced that it shows great affinity with the very polymorphic *D. rigululus*, and is a sub-species of the latter, but not of *D. luridus*. A. G.

**Hymenostomum in North America.**—A. LeROY ANDREWS (*Bryologist*, 1922, 25, 66-71). In this second contribution is considered the case of *Astomum Sullivantii*. First, *A. crispum* (Hedw.) Hampe is excluded as not being an American species. Then as to *A. Sullivantii* Br. & Sch., the earliest name of the plant is shown to be *Phascum Muhlenbergianum* Sw. (1818). The history of this is given, as also is the history of *A. Sullivantii* and *A. nitidulum*. The type of the latter sent by Schimper to Sullivant was lost by Sullivant in opening the letter, and no type specimen is to be found in Herb. Schimper. But the evidence collected seems to point to *A. nitidulum* being of hybrid origin; and the plants of it issued in Sullivant and Lesquereux's exsiccati were a form of *A. Sullivantii* which is synonymous with *Hymenostomum Muhlenbergianum* (Sw.). The differences between the American *A. Sullivantii* and the European *A. crispum* are pointed out. A. G.

**Stereophyllum Bremondii.**—R. POTIER DE LA VARDE (*Revue Bryologique*, 1920, 19-20, figs.). A description of *Stereophyllum Bremondii* Thér. & P. de la V., a new moss collected in Cambodia by M. de Brémond d'Ars. It is compared with *S. Blatteri* Card. from Bombay, and comparative drawings of the leaves and areolation of the two species are given. It is also compared with *S. anceps* Bry. Jav. from Java. A. G.

**Pedicle of Stereophyllum Bremondii.**—R. POTIER DE LA VARDE (*Revue Bryologique*, 1920, 35). In reply to an enquiry by H. N. Dixon the author states that *S. Bremondii* has a pedicle which is quite smooth, while that of *S. Blatteri* is highly papillose. A. G.

**Stereodon lignicola: a Rectification.**—I. THÉRIOT (*Revue Bryologique*, 1920, 71-2). An investigation of *Stereodon lignicola* Mitt. shows that this moss had a mixed diagnosis at the start, belongs to *Isopterygium*, but has been confused with a *Sematophyllum*. A description of the fruit is given. A. G.

**Cornish Sphagna.**—F. RILSTONE (*Journ. of Bot.*, 1922, 60, 263-7). A list of the species and varieties of *Sphagnum* found in Cornwall with their distribution, together with a discussion of the ecology of the *Sphagna*. The commoner species found in the county belong to the four groups, *Acutifolia*, *Cuspidata*, *Subsecunda*, *Cymbifolia*. The *Cuspidata* frequent deep pools on high moors. The *Subsecunda* have a wide range, from the deep pools to the peaty borders of badly-drained enclosures. The *Acutifolia* range from wet bogs to damp peaty roadside patches. The *Cymbifolia* prefer medium habitats, moderately wet moors and bogs. As lands are drained the *Cuspidata* are the first to disappear, then the robust *Subsecunda*, then the *Cymbifolia*, the last to disappear being the more delicate forms of the *Subsecunda* and some of the *Acutifolia*. Another point to be noted is that the plants of drier habitat are species which are abundantly supplied with pores on the dorsal surface of the branch-leaves, as opposed to the few-pored species of aquatic habit. There is a relation between pore-development and habitat. A. G.

**Early Stages in Bog Succession.**—GEORGE B. RIGG (*Publ. Puget Sound Biol. Station*, 1919, 2, 195–210). A study of some of the numerous instances of early stages of bog succession in the Puget Sound region. Lack of drainage is the main factor of bog formation. The *Sphagnum* bog advances on and succeeds the swamp. It gradually fills lakes, advancing by support of the woody or herbaceous bog plants. It often advances directly into shallow water without the aid of other plants. It may also be aided by free floating mats of vegetation. *Sphagnum* bogs develop on different types of soil, but slowly on well-drained soils. A. G.

**Muscineæ peculiar to the Auvergne.**—P. CULMANN (*Revue Bryologique*, 1920, 65–9). A discussion of the Muscineæ which are reputed to be peculiar to the Auvergne, and to occur nowhere else, in France at least. These, according to J. Héribaud, amount to 32 species. However, upon investigation, it is shown that only 2 out of the 13 hepatics on the list are limited to the Auvergne; while of the 19 mosses on the list, 7 are struck out at once, half-a-dozen are critical species, 1 or 2 are wrongly named, only 3 are well represented in Auvergne, while 8 are very rare there. It is impossible at present to estimate the exact number of bryophytes peculiar to the Auvergne, but it probably does not exceed half-a-dozen. A. G.

**Some Auvergne Mosses with Imperfect Peristome.**—P. CULMANN (*Revue Bryologique*, 1921, 17–22). A discussion which leads to the following conclusions:—*Tortula obtusifolia* is a sub-species of *T. muralis* and does not belong to the group *atrovirens-revolvens*. *Desmatodon arenaceus* must not be regarded as a form of the preceding, but constitutes a proper species—*T. arenacea*. *Grimmia plagiopodia* var. *arvernica* is characterized solely by the constant imperfection of its peristome. A. G.

**Bryological Notes from Sicily.**—W. E. NICHOLSON (*Revue Bryologique*, 1921, 38–43). The author and H. N. Dixon visited Sicily in April 1914, and obtained a number of bryophytes, comprising nearly 50 mosses and 16 hepatics; 14 of the mosses are additions to Bottini's list. A. G.

**Moss Flora of Granite Blocks in Lettland.**—N. MALTA (*Acta Universitatis Latviensis*, 1921, 1, 108–24; see also *Bryologist*, 1922, 25, 38). A list of 15 hepatics and 96 mosses which are true granite dwellers is supplied, and the question of the colonization of such erratic blocks in a lowland plain is discussed. Four associations of mosses are recognized—three of them controlled by relative exposure to sunlight, and the fourth (hydrophytic) by abundance of moisture. A. G.

**Considerations on the Moss Flora of New Caledonia and Diagnoses of New Species.**—I. THÉRIOT (*Revue Bryologique*, 1920, 69–71; 1921, 11–16, 22–8, 54–9). No more than 126 mosses of New Caledonia were known to Bescherelle in 1873, and this total remained stationary for thirty years; but thereafter the activities of A. Le Rat and his wife and of I. Franc added more than 300 species to the flora. The total has now risen to 528. Thériot hopes yet to find

leisure for writing a complete moss flora of New Caledonia. In the meantime he publishes diagnoses of 21 new species, 7 varieties, and a new genus—*Bryobrothera* (for *Mesoch te crenulata*); also records of 9 other additions to the flora, and several critical notes and corrections. A. G.

**Mosses of Annam.**—I. THÉRIOT (*Revue Bryologique*, 1922, 6-9, figs.). A report on a collection of 14 mosses made in Annam by F. Vincens, including 2 new species and 3 additional species for the Asiatic moss flora. A. G.

**Contributions to the Bryological Flora of Ecuador.**—V. F. BROTHERUS (*Revue Bryologique*, 1920, 1-16, 35-46). An enumeration of the mosses collected by the late Abbé Michel Allioni in the provinces of Oriente and Azuay in 1909-1910. The mosses of Oriente were previously unknown and contain several new species and a new genus. The total of species recorded in the present list is 160, and 35 of these are new to science. The new genus referred to is *Allionella*, belonging to the Sematophyllaceæ: it has been described in *Ofvers. Finsk. Vet. Soc. Fösh.*, 1910, 53, No. 15, with figures by Györfly. A. G.

**Contribution to the Moss Flora of Kikouyou.**—R. POTIER DE LA VARDE (*Revue Bryologique*, 1920, 49-54, figs.). An account of 29 mosses collected near Nairobi in British East Africa by J. Soul in 1912. Five new species and some new varieties are described. A. G.

**Hildebrandtiella Soulii.**—R. POTIER DE LA VARDE (*Revue Bryologique*, 1921, 9-11, figs.). A diagnosis by Brotherus and the writer. The species was collected with other mosses by J. Soul in Usambara. A. G.

## Thallophyta.

### Algæ.

**Investigation of the Plankton of the Irish Sea.**—SIR WILLIAM A. HERDMAN (*Journ. Linn. Soc. Bot.*, 1922, 46, 141-70, 1 pl.). A summary of the results of continuous investigation of the plankton of the Irish Sea during fifteen years. It is found that the spring phytoplankton maximum may range from March to June, and is chiefly composed of diatoms, comprising first *Chætoceros* and later *Rhizosolenia*. A month later comes the dinoflagellate maximum, and later still comes the copepod maximum. The organisms are more evenly distributed over the sea and downwards during the spring diatom maximum than at other times of the year. As a general rule the largest hauls come not from the surface, but from about 5 fathoms below; and most marine organisms seem to find their optimum of sunlight not in the maximum at the surface, but in the twilight lower down. The Irish Sea plankton is a mixture of oceanic and neritic organisms, varying in proportion according to the season. The dominant organisms of the plankton, whether diatoms or Copepoda, consists of a comparatively small number of genera, and these are the all-important organisms upon which the nutrition of higher animals, and ultimately of the food-fishes,

depends. Possibly, as Hjort suggests, the survival of large numbers of newly hatched food-fishes in early spring is determined by the amount of phytoplankton present, and thus is ensured or destroyed the prosperity of commercial fisheries a few years later. The vernal increase in phytoplankton seems to depend upon the rapid increase in the solar energy during the lengthening days of early spring. The diatom maximum in spring is doubtless aided by the winter increase of carbon dioxide and other food-matters in the sea, and the rapid disappearance of diatoms after the maximum may be due to some toxic effect upon the water caused by their own metabolism in dense crowds. Numerical conclusions cannot be with safety drawn from few and small samples of the plankton. Even when taken in rapid succession the hauls show great variation. The distribution of plankton is not uniform but in patches.

A. GEPP.

**Study of Some of the Factors Controlling the Periodicity of Fresh-water Algæ in Nature.**—WILLIAM J. HODGETTS (*New Phytologist*, 1921, **20**, 150-64, 11 figs. ; 195-227, 6 figs. ; 1922, **21**, 15-33, 2 figs.). An account of observations of the algal flora of a small pond near Birmingham from January 1918 to June 1921. It is presented under the following headings:—1. Introduction. 2. General account of Hawkesley Hall Pond and its phanerogamic flora. 3. Meteorological data. 4. Concentration of the water. 5. Algal flora of the pond—three groups : common, moderate, rare. 6. General account of the annual cycle of the predominant algal species. 7. *Spirogyra*. 8. *Zygnema* and *Mougeotia*. 9. Desmidiaceæ. 10. Oedogoniaceæ. 11. *Tribonema*. 12. *Microspora*. 13. *Vaucheria*. 14. *Aphanochæte* and *Draparnaldia*. 15. *Nitella* and *Coleochæte Nitellarum*. 16. Proto-coccales. 17. Volvocales. 18. Cyanophyceæ. 19. Flagellatæ. 20. General conclusions regarding the concentration of the water. 21. Summary of the chief results. A bibliography is appended. A. G.

**Life-history of *Staurostrum Dickiei*.**—CHARLES TURNER (*Journ. of Bot.*, 1922, **60**, 189-90). An account of the effect of the drought of 1921 upon the desmid *Staurostrum Dickiei* var. *parallelum*, resulting in the production of a great number of zygospores in mountain pools in Denbighshire. The spore contents were at first of an oily nature, obscuring the view of the nucleus ; but at a later stage the production of four nuclei was readily visible, an indication apparently of a diploid nucleus after conjugation, followed by a reduction division within the zygospore. The germination of the spore results in the formation of four, three, two or one desmid only, accompanied by an atrophy of some of the "mother cells." The process of conjugation is usually normal ; a conjugation tube is rarely observed. The conjugating desmids are asymmetrically placed. The conjugation of a 4-rayed with a 3-rayed form was not infrequent ; and both forms were seen in the protoplasm discharged from the same spore on germination. Vegetative propagation was often accomplished by the development of a single spherical bulging cell between the two semi-cells ; and the contents of this might divide, or an hour-glass constriction might cause ultimate formation of two desmids.

A. G.

**New Species of Spirogyra, with Unusual Arrangement of the Chromatophores.**—MABEL L. MERRIMAN (*Amer. Journ. Bot.*, 1922, 9, 283-4, figs.). A description of a new species of *Spirogyra*, *S. rectispira*, collected in New York City, and having filaments as thick as those of *S. crassa* (150-160 $\mu$ ), but distinguished from that species by having much smaller zygospores, and by the arrangement of its chromatophores, which are not spirally situated but longitudinal, parallel to the axis of the filament. Also the chromatophores of *S. rectispira* are much narrower, and the pyrenoids with their starch accretions much smaller than those of *S. crassa*. Both species grow together; but they never hybridize. A. G.

**Algæ from Merano.**—K. MÜNSTER STRÖM (*Nuova Notarisia*, 1922, 33, 126-34, figs.). An account of some fresh-water algæ collected at Merano in the Italian Tyrol in the autumn of 1921, from the only tarn in the district, from brooks, and from the trunks of trees. In all, forty-three species are enumerated, mostly desmids (including one new species). A. G.

**Investigation of Algæ in Moravia.**—R. DVORÁK (*Nuova Notarisia*, 1922, 33, 135-38). A summary of the researches that have been carried out on the fresh-water algæ of Moravia. J. Nave in 1863 recorded 407 species. Rudolf Dvorák and Oskar Richter have in later years published many additions, as also have Silvester Prát and R. Fischer. And a table is given which shows the progress made, and reveals a grand total of 1235 species. Notes on the more interesting species and forms are added. A. G.

**Notes on Some Algæ from British Columbia.**—WM. RANDOLPH TAYLOR (*Rhodora*, 1922, 24, 101-11, fig.). An enumeration of sixty-two fresh-water algæ collected in the late summer of 1921, during a camping expedition in the mountains of British Columbia, principally in the Selkirk and Eagle Pass ranges. Despite lack of transport, seventy samples were collected, half from alpine attitudes, half from low levels. A new species, *Rhizoclonium selkirkii* is described and figured; and a series of notes on the collection is given. A. G.

**Charophyta Collected in Ceylon.**—JAMES GROVES (*Journ. Linn. Soc. Bot.*, 1922, 46, 97-103, 1 pl.). An account of two collections of Charophyta by Thomas Bates Blow in Ceylon (1895 and 1898), comprising nine species of *Nitella* and four of *Chara*. *Nitella leptodactyla* is new to science, and is described and figured. A. G.

**Additions to Oceanic Algology.**—ANGELO MAZZA (*Nuova Notarisia*, 1922, 33, 97-125). A study of typical samples of certain genera of marine algæ—*Bonnemaisonia* and *Ricardia* (1 species of each); also in the Rhodomelaceæ the genera *Laurencia* (2 species), *Caloclonium* (1), *Chondria* (2) with 3 sub-genera; a third species, *Chondria crassicaulis* Harv. from Japan, is discussed with the feeling that it should be excluded from the genus. A. G.

**Life-history of Laminaria and Chorda.**—J. LLOYD WILLIAMS (*Journ. of Bot.*, 1922, 60, 191). A brief account of the sexual re-

production in these genera. The germinating zoospores produce two kinds of gametophytes, multicellular germings, one kind large-celled, the other of much smaller cells. The sexual generation was first noticed by Sauvageau in *Sacchoriza*. Lloyd Williams is now in a position to describe the discharge of the antherozoids and the process of fertilization, and also the process of dehiscence of the oogonium and the liberation of the eggs, for *Laminaria* and *Chorda* respectively. A. G.

**Variation in the Number of Ribs in *Costaria costata*.**—CATHARINE W. SMITH (*Publ. Puget Sound Biol. Station*, 1919, 2, 307-12, 1 pl.). An account of the variations found in the ribs of a large number of fronds of this species gathered in Puget Sound. The frond is usually stated to have 3-5 ribs; but in the series examined the number of ribs in mature fronds ranged from 4 to 9. In 4-ribbed fronds the typical midrib is absent. The midrib may disappear in part of a frond and reappear again below (the growing region is at the base of the frond). The side ribs may split into two or more, forming groups. No explanation of the variation is attempted. A. G.

**Age of *Pterygophora californica*.**—T. C. FRYE (*Publ. Puget Sound Biol. Station*, 1918, 2, 65-70, 1 pl.). A consideration of the evidence afforded by the rings of growth in the stalk of *Pterygophora* as to the age of the plant. Examination shows that there is a relation between the rings and the annual production of fronds. The rings appear to be annual growth rings, and the greatest number observed in any specimen was 21. Some other kelps show rings. A. G.

**Relation between the Osmotic Pressure of *Nereocystis* and the Salinity of the Water.**—ANNIE MAY HURD (*Publ. Puget Sound Biol. Station*, 1919, 2, 183-93). The osmotic pressure of this alga is intimately related to the concentration of the sea water, and decreases as the water becomes less saline. It will not tolerate a sudden change to fresh water, but can be gradually acclimatized to fresh water if the cell sap is allowed time to become adjusted to the outside concentration. The osmotic pressure of the plant in normal sea water as determined by the freezing-point method is 22.72 atmospheres. The osmotic pressure of Puget Sound water averaged 19.2 atmospheres. Throughout the adaptation of the cells of the plant to fresh water they maintain an average osmotic surplus of 3.62 atmospheres. The lowering of the osmotic pressure as the plant adapts itself to increasing dilutions of sea water is brought about (1) by the outward diffusion of salts, and (2) by the increased intake of water. A. G.

**Extraction and Separation of the Pigments of *Nereocystis Luetkeana*.**—GRACE E. HOWARD (*Publ. Puget Sound Biol. Station*, 1921, 3, 79-91). The object of the research was to find out what pigments could be extracted from *Nereocystis*, and at the same time to test Willstätter's statement that the lower plants contain the same four pigments as the higher plants. Willstätter's methods were used. The results are as follows:—1. Pigments which can easily be extracted from kelp are chlorophyll A, chlorophyll B, carotin, xanthophyll and fucoxanthin. The first four are found in the higher plants. 2. Magnesium

is present in chlorophyll. 3. There is good evidence that chlorophyllase is present. 4. Kelp chlorophyll can be put into a colloidal state. 5. This colloidal chlorophyll carries a negative charge. 6. These pigments cannot be extracted by pure solvents. A. G.

**Experiments with *Fucus* to Determine the Factors Controlling its Vertical Distribution.**—FLOYD W. GAIL (*Publ. Puget Sound Biol. Station*, 1918, 2, 139–51, 1 pl.). An account of experiments made on *Fucus evanescens*, the results of which are as follows:—1. Mature plants are more resistant to lower light intensities than are sporelings. 2. Desiccation of young plants is believed to prevent the growth of *Fucus* on gravel. 3. Reduced light intensities cause the death of well-grown plants 1 metre below the surface of the water. 4. Well-grown plants receiving less than quarter total light become darker in colour, and decomposition takes place. 5. Reduced light causes the death of oospores and sporelings when planted more than 3 decim. below the surface of the water. 6. Light is a controlling factor in determining the lower limit of *Fucus*. A. G.

**Hydrogen Ion Concentration and other Factors affecting the Distribution of *Fucus*.**—FLOYD W. GAIL (*Publ. Puget Sound Biol. Station*, 1919, 2, 287–306, 2 pls.). Experiments showed that the growth of sporelings and mature plants of *Fucus* is almost completely inhibited in sea water having a higher pH value than 8.6, and is much inhibited at 8.4; also at 8.6 and at a temperature above 24°C. these plants cannot live. Also when the pH value falls below 7.2 their growth is inhibited; and they are killed when the pH value falls to 7.0 and the temperature exceeds 24°C. *Fucus* does not grow on beaches where there is much *Ulva*, since the latter caused the sea water to have too high a pH value. The plasma membrane of oospores is sufficiently permeable to OH and H ions in sea water having pH values above 8.4 and below 6.8 to reduce the percentage of germination, and to inhibit the growth of sporelings. *Fucus* is not found on smooth gravel beaches (even where *Ulva* is not present) since the high temperatures and extreme desiccation decrease the germination and prevent the growth of sporelings. The oospores do not germinate in water of pH value 7.0, if the temperature is as high as 30°C. for 3 hours or more, and they are retarded at lower temperatures with pH values below 7.2. *Fucus* is absent from tide pools because the temperature is too high, and the extremes of the pH values are too far apart. Reduced light is a controlling factor in determining the lower limit of *Fucus*. The probable low pH value and low oxygen content of the sea water at any considerable depth may also be important factors. A. G.

**Taxonomy and Morphology of the Ligulate Species of the Genus *Desmarestia*.**—VINNIE A. PEASE (*Publ. Puget Sound Biol. Station*, 1920, 2, 313–67, 10 pls.). The ligulate species of *Desmarestia* are here discussed—namely, *D. ligulata* Lamour., *D. herbacea* Lamour., *D. latissima* Setch. & Gardn., and *D. foliacea* Pease, the latter two being described and figured for the first time. A key to these species and *D. pinna-tinervia* Mont. and *D. tabacooides* Okam. is provided. The rest of the

paper treats of morphology, including the following new points:—

1. The transitory assimilating hairs during the period of elongation in early spring differ in several species examined, and further examination in other species may lead to the conclusion that difference in assimilating hairs can be made to constitute a specific difference. 2. The primary axis of the assimilating hair is not regularly branched, but branches may occur singly or in pairs, and are separated by a varying number of axial cells. 3. At the end of the growing season the assimilating hairs are cut off by a definite method of abscission. 4. The cortical layer does not originate as filaments growing out from the basal cells of branch hairs which become applied to the axial cells, but as two groups of cells cut off from the basal cell of opposite paired branches, which divide without definite order, and produce a single layer of cells covering the axial cell and the bases of its lateral branches, and so form a flat thallus. 5. There are two systems of secondary tissues: (a) the "inner assimilation system" and "conducting hyphæ" which originate from the cells of the ground tissue; (b) the secondary outgrowths from the lateral branches of the axial filament or "original thallus," which in very broad species form a network of veins in the lamina, visible from the surface. 6. The cells of the axial filament and all its branches, both primary and secondary, develop into true sieve tubes.

A. G.

**Study of Susceptibility in some Puget Sound Algæ.**—C. M. CHILD (*Publ. Puget Sound Biol. Station*, 1919, 2, 249–67). Experiments made on nearly a score of living marine algæ with potassium cyanide, hydrochloric acid, ethyl alcohol, neutral red, potassium and sodium hydrates, methylene blue, and potassium permanganate. It was found that algæ with apical growth exhibit a gradient in susceptibility which decreases down along the axis. In branching thalli also the highest susceptibility is at the apices. In *Nereocystis* it is at the regions of most rapid growth—the upper end of the stipes and the basal end of the frond. The pseudothallus of the diatom *Navicula* shows a distinct gradient of susceptibility corresponding with the growth-form, the apical region of each axis being most susceptible. With neutral red and methylene blue the early stages of staining follow a similar gradient, and in washing out a weak stain of methylene blue the action is quickest in the apical regions. Permeability alone will not explain the susceptibility; a toxic substance either must alter the protoplasm in order to enter the cell, or else, passing through the protoplasm without killing it, produces its toxic effect by accumulating within the cell.

A. G.

**Cape Cod in its Relation to the Marine Flora of New England.**—WILLIAM ALBERT SETCHELL (*Rhodora*, 1922, 24, 1–11, 1 pl.). The importance of Cape Cod as a dividing point in the marine flora of the Atlantic coast of North America was first demonstrated by W. H. Harvey in 1852. The division between the northern and southern floras is however not sharp, as W. G. Farlow has shown; some of the northern species are found in exposed localities south of Cape Cod, and some southern species in a few sheltered spots north of the Cape. Frank S. Collins accumulated most valuable data as to the algæ along

the coast, and studied three distinct areas of warm spots north of Cape Cod. Further data were provided by B. M. Davis's survey; and now Setchell, who has made extensive collections along the coast of New England, sums up the facts and discusses the zones of temperature of the coastal waters, and the effect of the seasons and other conditions. A map is provided in which the lines of the isotherms and isocrymes are displayed.

A. G.

#### Fungi.

**Chytridiaceæ on *Codium mucronatum*.**—SANFORD M. ZELLER (*Publ. Puget Sound Biol. Station*, 1918-20, 2, 121-4, 1 pl.). Zeller found two species of Chytridiaceæ while studying the morphology of *Codium*—*Chytridium codicola* and *Rhizophidium codicola*. Full descriptions of these are given, and of the zoospores which were seen escaping from the sporangia. A species of Hyphomycete, *Stemphylium Codii*, was also formed on the alga; the parts attacked by it were pallid green, and, where the fungus was abundant, there was disintegration. All the fungi are new to science.

A. LORRAIN SMITH.

**Preliminary Study of *Claviceps purpurea* in Culture.**—WALTER W. BONNS (*Amer. Journ. Bot.*, 1922, 9, 339-52, 6 pls.). The work was undertaken to find out if *Claviceps purpurea*, the ergot of commerce, could be cultivated in sufficient quantities to supply commercial demands, the war having stopped the main source of supply from Russia. The writer describes the culture media used and the development of the fungus. He was able to follow the formation of the conidial stage directly from the sclerotium without the formation of ascospores. The data presented by the experiments seem to indicate that essential elements of ergot are absent in the cultures. The chemistry and toxicology of ergot and the presence or absence of the essential alkaloids in the cultures are fully described.

A. L. S.

**Little-known Forms of Endomycetaceæ.**—G. MANGENOT (*Bull. Soc. Mycol. France*, 1922, 38, 42-55, 2 pls.). The author gives a short account of the mode of fertilization in *Eremascus* and in the various species of *Endomyces* where there is "seriation" based on the disappearance of sexuality. In some species there is well-marked copulation between two cells, in others the development is parthenogenetic. He then gives a full account of his observations on two species. In *E. javanensis* the mycelium is reduced and tends to break up into separate cells. Ascospores may arise in any of these cells, recalling strongly the spore-formation of yeasts. Another species, *E. Lindneri*, has been exhaustively studied. In the mycelium there is constant anastomosis before the formation of the asci, a new instance of sexuality "on the way to abolition." Another species, *E. Hordei*, was found to be closely akin to *E. Lindneri*, but entirely parthenogenetic. *E. Lindneri* is used for making beer in China.

A. L. S.

**Cordyceps in New Zealand.**—G. H. CUNNINGHAM (*Trans. New Zealand Inst.*, 1921, 53, 372-82, 4 pls., 7 figs.). The author recognizes five species and two doubtful species for New Zealand; all of these are parasitic on various larvæ. An account of their life-history is given,

and then follows detailed descriptions of the several species, four of which are endemic, still another being found in addition in Australia and Tasmania. From the sclerotium of *Cordyceps Robertsii* a pigment was obtained which was used by the Maori for tattooing. A. L. S.

**Studies in Tropical Ascomycetes.**—FRED J. SEAVER (*Mycologia*, 1922, 14, 235–8, 1 pl.). The writer proposes to issue a series of studies on tropical species. The present paper deals with *Neopeckia diffusa* and *Herpotrichia albidostoma*, which have a wide range of distribution both within and outside the tropics. Externally the two fungi are similar, but internally they are very different, especially in the form and septation of the spores. The writer contributes diagnoses and synonymy. A. L. S.

**Life-history of an Undescribed Ascomycete Isolated from a Granular Mycetoma of Man.**—C. L. SHEAR (*Mycologia*, 1922, 14, 239–43, 3 figs.). The fungus was isolated from a sore in a foot caused by a thorn some twelve years previously. The doctors presumed that the organism had entered the foot with the thorn, and it had persisted; occasionally the wound healed over, but always burst out again. The fungus was developed on culture media, and produced a coremium stage (*Dendrostilbella*) and a perithecium with thin delicate walls and no opening. It has been placed by the author in the genus *Allescheria*. A. L. S.

**Studies in Discomycetes. III.**—JESSIE S. BAYLISS ELLIOTT (*Trans. Brit. Mycol. Soc.*, 1922, 7, 293–8, 2 figs.). The writer publishes observations on a number of the smaller Discomycetes. *Arachnopeziza aurata* she has watched growing all the year round, though it is most flourishing from June to October. As there is no subiculum, the early stages, resembling those of *Eremascus albus*, were easy to follow. Particular note is taken of the peculiar paraphyses of *Dasyascypha diplocarpa*; they are much branched, the tips bearing pale green septate conidia. Other Discomycetes are described, and previous errors in description are rectified. A. L. S.

**Taxonomic Note on the Group Melanomma.**—J. E. CHENANTAIS (*Bull. Soc. Mycol. France*, 1922, 38, 88–92). The writer finds that spores provide the best diagnostic characters in this genus, which contains some eighty-two species. He divides these into "types" according to the size of the spores. The last section has very large spores, which indicates affinity with *Trematosphaeria*. A. L. S.

**Septoria Species and the Formation of Higher Fructification.**—F. LAIBACH (*Zeitschr. Pflanzenkr.*, 1920, 30, Heft 6–7). By means of cultures the author has succeeded in proving the connexion of various species of *Septoria* with the fructifications of the Pyrenomycete *Mycosphærella*: *Septoria Rubi* developed into a *Mycosphærella* similar to *M. idæina*; *Septoria Aucupariæ* was proved to be a stage of *Mycosphærella Aucupariæ*. Other results are also given. A. L. S.

**Demonstration of numerous Distinct Strains within the Nominal Species Pestalozzia Guepini Desm.**—CARL DE LA RUE and

H. H. BARTLETT (*Amer. Journ. Bot.*, 1922, 9, 79-92). The tropical Pestalozzias have not been well defined. *P. Guepini* is the general name given to those that grow on *Hevea*, and the authors of the paper have paid special attention to that one. They have secured by culture thirty-five different strains which can be allocated to fourteen groups, each group containing one or more strains that cannot be placed in any other group.

A. L. S.

**Studies in the Genus Gymnosporangium. IV.**—B. O. DODGE (*Amer. Journ. Bot.*, 1922, 9, 354-65, 1 pl., 7 figs.). The writer has investigated the distribution of the mycelium and the subcuticular origin of the telium in *Gymnosporangium clavipes*. He describes the host leaf and the area of infection by the parasite—directly on the leaves or in stems at the edges of the decurrent leaf-bases. In later years, as cork is formed, sori arise and break through in the ordinary manner. The teleutospores grow out from the subterminal cells of the basal primordium, the terminal cells having become disorganized, and being swollen function as buffer cells. The mycelium is first found in the cuticularized layer of the epidermal cells, later in the mesophyll.

A. L. S.

**New Biological Species of the Type of Puccinia sessilis.**—EUG. MAYOR (*Bull. Soc. Mycol. France*, 1922, 38, 34-41). The author noted from year to year in the Jura an abundant growth of æcidia on *Paris quadrifolia*, *Convallaria majalis*, *Polygonatum multiflorum*, and *P. verticillatum*. The *Puccinia* of these hosts formed teleutospores and uredospores on *Phalaris arundinacea*, but as no plant of that type grew in the area Mayor looked round for another alternate host, and decided that *Festuca silvatica* must be the one. His surmise was correct, and he proved it by infection experiments. There are thus two æcidia on *Paris quadrifolia*, etc., agreeing exactly in their morphology, but differing absolutely in their alternate hosts, the one being *Phalaris arundinacea*, the other *Festuca silvatica*.

A. L. S.

**Vegetative Vigour of the Host as a Factor influencing Susceptibility and Resistance to certain Rust Diseases of the Higher Plants.**—M. A. RAINES (*Amer. Journ. Bot.*, 1922, 9, 183-203, 215-38, 2 pls.). As a result of prolonged and varied culture experiments, the author considers that evidence is forthcoming of a direct relation between the vigor of the host and the virulence of the disease. The results are directly affected by the age and maturity of the host. Results also vary according to species. In some of the experiments there was an increased incidence of infection with depression in the growth rate of the host.

A. L. S.

**Contribution to the Knowledge of Ustilagineæ. II.**—F. RAWITSCHER (*Zeitschr. für Botanik*, 1922, 14, 273-95, 2 pls.). The writer has worked at the cytology of a number of fungi belonging to this family. In *Tilletia Triticum* reduction division of the nuclei takes place in the spore, and there are as many nuclei formed as later there are sporidia on the promycelium. In *Cintractia Montagnei* the first nuclear division takes place in the germination of the promycelium. There are

two different methods of division in the four promycelial nuclei. Copulation takes place between the first four cells of the promycelium in *Cintractia*, and that also may occur in two different ways—between two neighbouring cells or between the two end cells. *Urocystis Violæ* resembles *U. Anemones*, as described by Knieps, only in the former there are formed generally eight primary and four secondary bi-nucleate spores. In *Dassansia Sagittariæ* the bi-nucleate stage appears first before spore formation, somewhat as in *Ustilago Maidis*. A. L. S.

**Notes on Coleosporium. I.**—G. G. HEDGCOCK and N. REX HUNT (*Mycologia*, 1922, 14, 244–57, 2 pls.). The authors have made inoculations of a series of species of *Coleosporium*, the æcidia of which grew on various pine needles. The species inoculated are given and the results obtained in each case, and the different species are compared.

A. L. S.

**Urocystis Agropyri on Redtop.**—W. H. DAVIES (*Mycologia*, 1922, 14, 279–81, 1 fig.). The smutted plants of redtop (*Agrostis palustris*) were collected at Madison, Wisconsin. The fungus grows on a considerable number of grasses; its occurrence is duly recorded. A special description is given of the spore-balls, etc., of *U. Agropyri*.

A. L. S.

**New Japanese Fungi.**—TŌZABURŌ TANAKA (*Mycologia*, 1922, 14, 282–95). These fungi are all species of *Gymnosporangium*. Tanaka gives full descriptions with localities, collectors, etc. He winds up with a synoptic key of the species.

A. L. S.

**Basidial and Oidial Fruit-bodies of Dacryomyces deliquescens.**—A. H. R. BULLER (*Trans. Brit. Mycol. Soc.*, 1922, 7, 226–30). The two species known as *Dacryomyces stillatus* (orange-red) and *D. deliquescens* (yellow) had been identified by Tulasne as stages in the life-history of one fungus. The discovery was confirmed by Brefeld, and in the present paper the life-history is given, and the two forms described in detail. Both forms grow on rotten wood and are of frequent occurrence. The darker form (orange-red) bears only oidia; the yellow form basidiospores, which develop very quickly and are simple when mature, but after lying in water for some time they become 3-septate. Buller noted that the yellow fruit-bodies were very pale or almost colourless in the shade.

A. L. S.

**Rhizopogon diplophloeus in Washington.**—SANFORD M. ZELLER (*Publ. Puget Sound Biol. Station*, 1918–20, 2, 95–6). This *Rhizopogon* was described by Zeller and Dodge from Western Washington; a fuller account of the fungus is now given.

A. L. S.

**Secotium acuminatum in France.**—M. BARKER (*Bull. Soc. Mycol. France*, 1922, 38, 29–30, 2 figs.). This rare member of Gastromycetes was found by the author at Lux, near to Dijon, on calcareous earth near a wood. Its presence there might be explained by the neighbourhood of an American cavalry camp. The species has been reported from Algiers, Russia and Central Asia.

A. L. S.

**Fungi from the Higher Rhone Valley.**—J. COURTILLOT (*Bull. Soc. Mycol. France*, 1922, **38**, 31–3). The author records several of the larger Agarics : species of *Tricholoma*, *Clitocybe*, *Russula*, etc. He takes occasion to note observations as to odour, taste, habitat, etc., that do not always accord with the published descriptions. A. L. S.

**Notes on *Boletus sphærocephalus*.**—L. CORBIÈRE (*Bull. Soc. Mycol. France*, 1922, **38**, 71–7, 1 pl. col.). The author found a continuous growth of this rare *Boletus* on sawdust. It is very near to *Boletus sulphureus*, but the latter is smaller, non-viscous, and is tomentose, squamose, and with cystidia. It is edible and occurs on sawdust heaps. A. L. S.

**Observations on the Affinities of *Boletus sulphureus* Fr. and *B. sphærocephalus* Basla.**—M. PELTEREAU (*Bull. Soc. Mycol. France*, 1922, **38**, 78–82). The fungus observed by Corbière was submitted to M. Peltereau, who considered it to be a form of *Boletus sulphureus*. He gives his reasons for this determination, and finds that the differences may be due to habitat—*B. sulphureus* growing on pine needles, etc., while *B. sphærocephalus* is confined to saw-dust heaps. A. L. S.

**Dark-spored Agarics. IV., *Deconica*, *Atylospora* and *Psathyrella*.**—WILLIAM A. MURRILL (*Mycologia*, 1922, **14**, 258–78). Murrill gives complete diagnoses of the various species. Many of them are confined to America. A number of new species are described, more especially in the genus *Atylospora*. A. L. S.

**New Facts concerning *Boletus Satanus* and its Allies.**—HEINRICH LOHWAG (*Oesterr. Bot. Zeitschr.*, 1922, **71**, 129–34). The paper is mainly concerned with the colouring of the flesh of these fungi on exposure to air, etc. Lohwag finds errors concerning this in the descriptions, but in general he notes that the red colour is closely associated with the blue coloration, while the blueing depends on the strength of the yellow colour present. Fungi that turn blue may also turn red ; and also the normal red colour may be absent from the stalk and the pores. *Boletus Satanus* can have yellow flesh which turns immediately blue. In view of his observations on the presence or absence of colour and the colouring action of the air, etc., he finds it necessary to make some important changes of specific determination, as for instance : *Boletus versicolor* is a perishable form of *B. chrysenteron*, the latter being itself a form of *B. subtomentosus* ; similarly *B. calopus* and *B. purpureus* are perishable (or perishing) forms of *B. luridus*. Further critical notes on the subject, with a list of species in the *Luridus* group, have been published more recently (*Hedwigia*, 1922, **63**, 323–8). A. L. S.

**Homothallism and Heterothallism in the Genus *Coprinus*.**—IRENE MOUNCE (*Trans. Brit. Mycol. Soc.*, 1922, **7**, 256–69). The author has made a detailed study of several species of *Coprinus* to determine the occurrence and significance of clamp-connexions in the developing mycelium. The paper is a continuation of a previous paper (pp. 179–217) on the production of fruit-bodies by monosporous

mycelia in the same genus. Clamp connexions are a sign that the mycelium on which they arise is the diploid and not the haploid condition. The methods are described, and the following conclusions are reached:—*Coprinus sterquilinus* and *C. stercorarius* form clamp connexions and fruit-bodies in monosporous cultures; they are homothallic. *Coprinus lagopus* and *C. niveus* are heterothallic species, but it is possible that they give rise, at times, to homothallic strains; in these respects they would be similar to *Schizophyllum commune*. A. L. S.

**British Mycological Society.**—(*Trans. Brit. Mycol. Soc.*, 1922, 7, 221-4). An account is given of the Haslemere Spring Foray of 1921, and of the results of the days' excursions. The evenings were spent at the Museum, Haslemere, where the specimens were examined and compared. In consequence of the dry weather there was a scarcity of larger fungi, but many interesting species were collected and have been listed. Eleven species of Mycetoza are included. A. L. S.

**Slugs as Mycophagists.**—A. H. R. BULLER (*Trans. Brit. Mycol. Soc.*, 1922, 7, 270-83). The experiments described by Buller were carried out in England. He finds that in Central Canada, owing to the dry cold climate, and to the fact that fleshy fungi are extremely abundant in the woods, such fungi evidently do not depend on slugs for spore dispersal. The writer gives an account of the fungi attacked by slugs, and shows that certain species can attract *Limax maximus* a distance of 21 ft. As slugs are known to be short-sighted they must be attracted by the sense of smell. This extreme sensitiveness of slugs to smell was taken advantage of in the war to detect the presence of mustard gas. A. L. S.

**Mycorrhizal Fungi of Pinus silvestris and Picea Abies.**—ELIAS MELIN (*Svensk Bot. Tidsk.*, 1921, 15, 192-203, 4 figs.). The author made cultures of a number of mycelia from the roots of the trees and reinfected seedlings. He is of opinion that the *Mycorrhiza* is not conveyed by the seeds. He discusses the question of the gain to the host plant—that being mainly the supply of nitrogen. It is possible that the mycelia have the power of fixing nitrogen from the air. Experiments are still being tried. A. L. S.

**Associated Growth of certain Boleti and Pine Trees.**—LARS-GUNNAR ROMELL (*Svensk Bot. Tidsk.*, 1921, 15, 204-13, 4 figs.). The paper has a bearing on the question of *Mycorrhiza*: the writer's principal observations concern *Boletus luteus*, which grows in pine woods, and is not found in any locality entirely free from conifers. The mycelium was examined, but it was of a mixed nature, and other *Boleti*, etc., were present in the area. The writer concludes, however, that there is strong evidence of specialization in the fungi associated with trees. A. L. S.

**Relation of Soil Moisture and Soil Temperature to Bunt Infection in Wheat.**—C. W. HUNGERFORD (*Phytopathologist*, 1922, 12, 337-52). Bunt, or stinking smut of wheat, is a very serious trouble in the North-West Pacific parts of America. It is believed that the soil is contaminated by wind-blown spores, and that these germinate along with the wheat and infect the host seedlings. "Pre-

liminary experiments appear to indicate that spores of *Tilletia Tritici* in the soil lose their power to infect rather rapidly when the soil is moist and is cultivated frequently. Very little infection took place from spores which had been in the soil one month under the above conditions."

A. L. S.

**Environmental Temperatures of Fungi in Nature.**—NEIL E. STEVENS (*Amer. Journ. Bot.*, 1922, **9**, 385-90, 1 fig.). The author made his experiments on parasitic leaf fungi, and found that many plant parts affected by fungi show, when exposed to the sun, a temperature above that of the air. He noted also that these fungi are subjected to fluctuations more rapid and extreme than the fluctuations in the temperature of the air in the shade. Their environment in nature is thus widely different from that of fungi cultivated in heated laboratories.

A. L. S.

**Fungus-flora of Egypt: a Mycogeographical Study.**—J. REICHERT (*Engler's Bot. Jahrb.*, 1922, **56**, Heft 5; see also *Hedwigia*, 1922, **63**, Beiblatt 112-3). One of the first papers to treat fungi from a geographical stand-point. The writer gives a sketch of work done on the Egyptian fungus-flora, and of the ecological conditions with the fungus vegetation, and the ecological adaptations. Ustilaginæ and Gasteromycetes, which are abundant in deserts, represent Xerophytes among fungi. Among the few *Agarics*, *Coprinus clavatus* var. *arenosa* manages to survive by its strongly developed rhizoidal mycelium, and Ustilaginæ, by developing their spores within the host-plant, are also adapted to dry conditions. Reichert records 237 species, 38 of which are new, 60 are widely distributed, and 68 are endemic.

A. L. S.

**Studies in the Physiology of the Fungi. XII., Physiological Specialization in Rhizoctonia Solani.**—TAKASHI MATSUMOTO (*Ann. Miss. Bot. Garden*, 1921, **8**, 1-62). The author experimented in different media with 15 different isolations of the fungus obtained from a wide range of hosts. He divided them into two main groups: (1) those that blacken the agar culture medium: and (2) those that do not blacken agar. He has recorded many results of his work. The following are a few of the findings:—All the strains hydrolyze starch, though the diastatic activity is unlike, and all convert cane sugar. None of them could utilize inulin, but glucose, fructose and galactose were utilized. . . . As a whole the mycelial growth is more sensitive to modification in the carbohydrate supply than to changes in the nitrogen supply. The hyphæ of the fungi may enter the host directly through the cuticle by a mechanical process, and more easily through the root. The differences between the different strains are noted. A very copious bibliography is appended.

A. L. S.

**Metabolism of Thermophile Fungi.**—KURT NOACK (*Jahrb. Wiss. Bot.*, 1920, **95**, 416-66). The thermophile fungi were considered by Mieke to be *Actinomyces thermophilus*, *Thermoidium sulfureum*, *Mucor pusillus* and *Thermoascus aurantiacus*; the author adds another to the group, *Anixia spadicea*. The life process of these is of great interest, as to that is due the heating of hay, etc. The respiration process has

been chiefly examined with reference to temperature and to the rate of growth. The results of experiments are given in great detail.

A. L. S.

**Occurrence of certain Fungi in great Abundance after Forest Fires.**—LÉON DUFOUR (*Bull. Soc. Mycol. France*, 1922, **38**, 93-7). The fungi that mainly appear on burnt soil are species of Discomycetes, *Plicaria leiocarpa*, *Aleuria violacea*, *Geopyxis carbonaria*, etc. The author considers one of the chief influences to be the letting in of light and air, and certain chemical modifications of the soil. These modifications probably exist only a short time.

A. L. S.

**Wood-staining Fungi.**—B. D. MACCALLUM (*Trans. Brit. Mycol. Soc.*, 1922, **7**, 231-6, 2 pls.). The paper is concerned with the biology of blue-rot in timber or the blueing of pine wood. This is due to the action on the wood of species of *Ceratostomella*, a Pyrenomycete. MacCallum has investigated the life history of one of these, *Ceratostomella Piceæ*, and he concludes that the hyphomycetous stage is *Graphium penicillioides*. The results of the various cultures are fully described.

A. L. S.

**New Species of Fungi.**—N. PATOUILLARD (*Bull. Soc. Mycol. France*, 1922, **38**, 83-7). A number of new species are described from various tropical countries east or west. The author gives a new genus of Nectriaceæ, *Eriospora*, with one species, *E. parasitica*. It is distinguished by the numerous small brown spores in the ascus.

A. L. S.

**National Collection of Type Cultures.**—R. ST. JOHN BROOKS (*Trans. Brit. Mycol. Soc.*, 1922, **7**, 237-9). The writer has been appointed to the curatorship of type cultures at the Lister Institute. For some time bacterial cultures have been supplied to workers; lately fungi have been added, and the writer indicates the kinds of fungi that are of value in such a collection, and their use to workers.

A. L. S.

**Cases of Poisoning by *Amanita pantherina*.**—E. DALMIER and OLIVEAU (*Bull. Soc. Mycol. France*, 1922, **38**, 100-5). Three persons partook of the fungus, which was gathered in a mistake for *Lepiota*. The authors describe the symptoms of poisoning; the effects, which lasted for several weeks, did not prove fatal.

A. L. S.

**Poisoning by Dried Fungi.**—J. OFFNER (*Bull. Soc. Mycol. France*, 1922, **38**, 116-8). The dried fungi were served in a restaurant at Grenoble, and seven persons were attacked with severe symptoms of poisoning, though not fatal. Some fungi lose their toxicity by drying, but not all of them. The whole matter is fully discussed.

A. L. S.

**Symptoms of Wilting of Michaelmas Daisies produced by a Toxin secreted by a *Cephalosporium*.**—W. J. DOWSON (*Trans. Brit. Mycol. Soc.*, 1922, **7**, 283-6). The fungus grows on a watery medium in the form of a slimy sheet of mycelium, with the copious production of minute conidia. This medium was filtered, and into it were placed green shoots of Michaelmas Daisies. Mottling, paling and yellowing of the leaves took place, and the same results occurred in inoculation experiments with the *Cephalosporium*. Microscopic experiments were

made on the chlorophyll cells with the filtered liquid, and it was observed that the chloroplasts became massed at one or both ends of the cell; finally, they lost their shape and colour, and at the end of the sixth or seventh day had become an irregular mass. A. L. S.

**Discomycete found on Medlar Fruits.**—H. WORMALD (*Trans. Brit. Mycol. Soc.*, 1922, 7, 287–93, 2 figs.). Mummified medlar fruits collected from the ground in spring and placed in favourable conditions developed a fungus that differed very slightly from *Sclerotinia Mespili*. The writer considers it is probably the origin of the leaf blotch of medlar trees, as *Monilia* fructifications were found on the leaves, but all attempts to prove their connexion by inoculation have been unsuccessful. The author has detailed the development of the apothecia and spores. A. L. S.

**Rhizoctonia Solani as a Potato-tuber Rot Fungus.**—M. SHAPOROV (Phytopathology, 1922, 12, 334–6, 1 pl.). The author has proved that the well-known potato parasite *Rhizoctonia Solani* is also a cause of a jelly-type of rot in the tubers. He describes the inoculation experiments undertaken by him to discover the cause of the decay. A. L. S.

#### Lichens.

**Lichens of Somalia.**—CARLO ZANFROGNINI (*Nuova Notarisia*, 1917, 28, 145–75). A study of the corticolous lichens of this region of Africa. The author has added to his descriptions numerous biological and morphological observations as well as critical systematic notes. He has given special attention to chemical reaction with various solutions. A. LORRAIN SMITH.

**Lichens of Wolbeck.**—F. TOBLER (*Hedwigia*, 1921, 63, 7–10). The author comments on the large number of rare lichens that were found by Lahm in the Wolbeck zoological gardens in Westphalia (1856–1885). There has been much change since. The trees have increased, many of them have been felled, etc., and the lichens have very much decreased. He concludes that lichens are very sensitive to the change of environment; chief among the changes is that of moisture, which has increased beyond the stage most favourable to lichen growth. A. L. S.

**Lichens of Alaska.**—ALBERT W. C. T. HERRE (*Publ. Puget Sound Biol. Station*, 1918–20, 2, 279–85). About 462 species and varieties of lichens have hitherto been enumerated for Alaska: the present list brings the total up to 482. Dr. Herre makes interesting notes on some of the families. He looks on the lichen as a physiological species—a fungus with an enslaved alga. Several of the species recorded are rare plants. A. L. S.

**Growth and Regeneration of the Thallus of Peltigera canina.**—CL. STRATO (*Hedwigia*, 1921, 63, 11–42, 13 figs.). The growth of the thallus takes place at the circumference. The isidia may be reckoned also as circumference growth, though they grow on the surface.

Frequently they take origin after some injury to the thallus, or they are induced by the urgent growth of the algæ. Isidia are of service as subsidiary reproductive bodies. Portions of the thallus are of service in regeneration if the medullary tissues are present; the cortex, possibly owing to the felted hairs on the surface, takes no part in the renewal of growth. The influence of light, which is a necessity for the life of the gonidia, is one of the essential factors of thallus regeneration. Moisture, which is also of influence, depends on the connexion of the regenerating thallus with the water storage of the substratum. Regeneration did not follow under a moist bell-glass if the substratum was a mica plate instead of the normal earth or moist clay.

A. L. S.

**Lichens of Haslemere District.**—H. H. KNIGHT (*Trans. Brit. Mycol. Soc.*, 1922, 7, 225). Most of the lichens found at the Spring Foray, Haslemere, were growing on wood; the few saxicolous species collected occurred on stone walls, etc. The list numbers about sixty-six species.

A. L. S.

**Determination of Lichens in the Field.**—W. WATSON (*Journ. Bot.*, 1922, 60, Suppl. 17–28). The author has given a further installment of his key for lichens from field characters. Mostly he deals with genera only, but not infrequently species also are included. He has given an additional key to those with crustaceous thallus when the fructification is wanting.

A. L. S.

**Physiology of Crustaceous Lichens.**—E. BACHMANN (*Zeitsch. für Botanik.*, 1922, 14, 193–233). The author comments on Zukel's view that the immersion of the thallus in limestone was a shelter against the depredations of animals; he considers, however, that water supply is the chief advantage to be gained. The research was carried out on herbarium material which was exposed to dew or rain or soaked in water after being thoroughly dried. The wet thallus was then exposed to sunlight. In nature water is absorbed from rain, dew or moist air. The rate of water absorption from these different sources is calculated for a number of lichens, and the evaporation of water from the specimens is also calculated and compared. Comparison is further made with samples of limestone free from lichens. The stone containing the lichen thallus has a greater capacity of absorption than the free stone, and also it retains the moisture longer. In comparing lime lichens with each other he finds that those associated with *Trentepohlia* have a greater capacity of water absorption than those with *Pleurococcus* gonidia—in the former the lime is more deeply pierced by the penetrating filaments of the alga. He contrasted silicolous lichens with calcareous, and found that the latter had again the greater capacity of absorption.

A. L. S.

**Cultures of Nostoc-gonidia from Peltigera Species.**—K. LINKOLA (*Ann. Soc. Zool. Bot. Fenn. Vanamo*, 1920, 1, 1–23, 1 pl., 7 figs.). The author cultivated the gonidia of eight species in various culture media. The algæ not only grew well but formed hormogonia, the first time these bodies have been cultivated from the lichen; occasionally they developed into spores, at other times they formed *Nostoc* colonies.

Linkola says unhesitatingly that he was dealing with the same *Nostoc* species throughout—*N. punctiforme*—and he considers that all the *Nostoc Pelligera* gonidia belong to the same species. The only instance of variation was found in *Pelligera malacea*, which may indicate some specific difference, or a physiological race. A. L. S.

**Vitricole Lichens and the Deterioration of Church Windows.**—ETHEL MELLOR (*Rev. Gén. Bot.*, 1922, **34**, 280–6, etc., 336–45, 4 pls., 4 figs.). The writer gives a list of the lichens she has determined from window glass. There is one new species, *Caloplaca vitricola*, with var. *violacea*, of which the spores are polari-ocular, but the lichen gives no reaction with potash. The conclusions she comes to are as follows:—The immediate cause of corrosion is the mechanical action of the lichens on glass which has been altered chemically by moisture; the silicates become more or less hydrolyzed, with formation of silicic acid and hydrates of calcium and sodium. The presence of lichens hastens the alteration that has already taken place. The glass coloured yellow sometimes resists corrosion a long time. To save the glass it suffices to clean the windows annually. The glass is sometimes pierced to a depth of 1.6 mm. and to a width of 5 mm., and occasionally it may be perforated. A. L. S.

**Lichens of Bolivia.**—TH. HERZOG (*Hedwigia*, 1922, **63**, 263–8). The author of the paper collected mosses and lichens on his second journey through Bolivia (1910–11). The mosses have already been named by himself; the lichens were submitted to Zahlbruckner, and the results are now published. The forms collected were the more evident plants, and give a fair indication of the types of lichens prevalent in the country. A. L. S.

**Lichens of North Bohemia. Contribution III.**—JOSEF ANDERS (*Hedwigia*, 1922, **63**, 269–304, and 321–2). A very large number of lichens have been listed. The author comments on the absence of calcareous rocks; basalts and siliceous rocks bore an abundant crop, and tree forms were many and varied. A few forms or species are new to the district, or new to science. A. L. S.

### Mycetozoa.

**Notes on Malayan Mycetozoa.**—A. R. SANDERSON (*Trans. Brit. Mycol. Soc.*, 1922, **7**, 239–56). The writer gives a review of work already done on Malayan Mycetozoa. He then describes the conditions of timber growth, of temperature, etc. He states that Mycetozoa require very careful search in the virgin forest: their rarity is probably due to the abundant insect life. An account is given of the creatures that feed on the sporangia: ants are the most active and eager. A note is given as to the best methods of collecting and storing in the difficult tropical climate, and then follows a list of the species with very full biological descriptions. To the paper are added tables of the rainfall and of the occurrence and habitats of Malayan species. The habitats dealt with are:—*Hevea* logs, coconut, other palms, dead jungle

logs, living trees, and leaves. Most of the specimens were found on *Hevea* logs or on dead jungle logs.

A. LORRAIN SMITH.

**Parasitic Habits of the Plasmodium of *Physarum viride* var. *rigidum*.**—A. R. SANDERSON (*Trans. Brit. Mycol. Soc.*, 1922, **7**, 299–300). Notes were made by the author on the habitat of this Mycetozoon in tropical Malaya. Usually it was found on decaying logs of *Hevea brasiliensis*, and frequently on or near the pilei of *Schizophyllum*. Sanderson found that the plasmodium grew over the pilei and killed them. It grew also abundantly on *Hirneola*, but failed to develop on *Daldinia*, *Nummularia* and *Ustulina*; when transferred to these fungi the plasmodium died.

A. L. S.

## MICROSCOPY.

## A. Instruments, Accessories, etc.

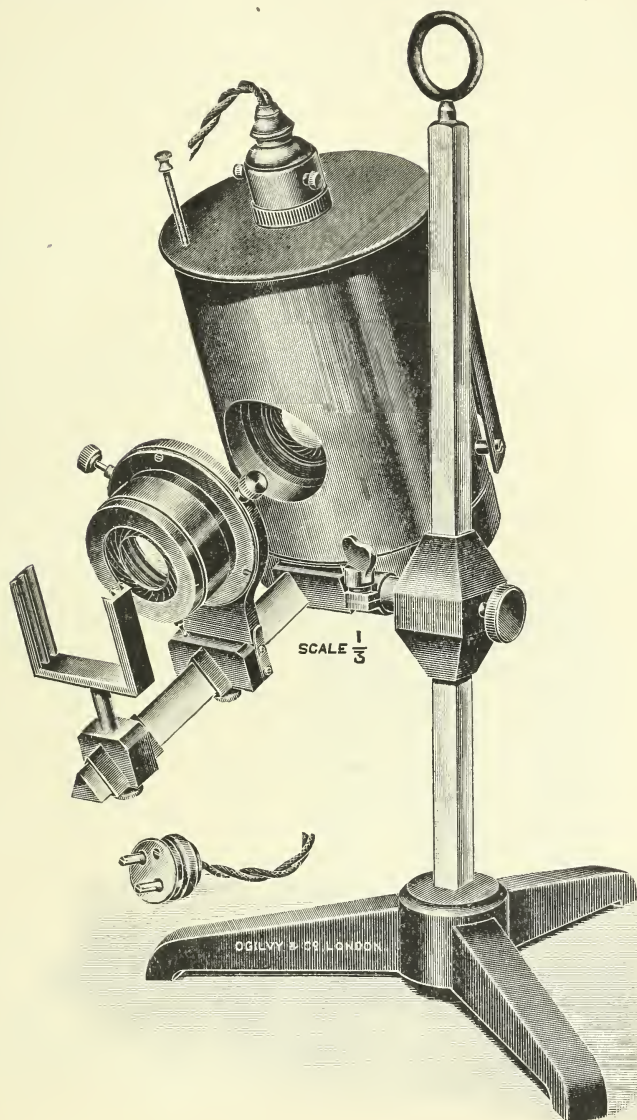
## (3) Illuminating and other Apparatus.

**A New Electric Microscope Lamp for Research Work.**—Since the introduction of the incandescent electric lamp, numerous forms of lamp hoods and shades have been designed for use with the microscope, none of which have proved entirely satisfactory. In this new model there are features embodied which are not to be found in any patterns hitherto used for microscope illumination. The hood is of generous proportions, and so constructed that it gives the maximum of ventilation combined with the minimum of reflection, which materially lessens the strain and fatigue experienced in long periods of microscopical observations. The hood, or holder, takes the form of a vertical cylinder made from planished steel sheet having a flat top fitted with a strongly made push-bar switch with lamp socket of the standard bayonet catch pattern, and provided with twin flexible wire and standard two-prong wall-plug. On the front and inside of the lamp hood is permanently fitted an iris diaphragm, which is close to the side of the electric bulb: this diaphragm serving the double purpose of regulating the size of the source of light as required, and enabling the user to project an accurately focussed image of the radiant.

The lamp hood is fitted to a circular base made of cast brass and is detachable. At lower edge of hood a slot is cut which fits over a clamping screw with milled head, and ensures hood being replaced to the correct position of alignment. In front of the circular base is attached a small prismatic optical bench carrying two adjustable supports, or saddle stands, for supporting a condensing system, iris diaphragm and light filter holder. The condensing system holder is made somewhat after the manner of the typical English substage mechanism of the microscope, but of larger proportions, and is fitted with centring screws so that the condenser may be accurately centred to the permanently fixed iris diaphragm, and also may be interchangeable. This holder is on a hinged mount that the condenser may be conveniently swung out of the optic axis when not required, and a strong spring catch ensures accurate alignment when replaced. The light filter holder supplied may be of the pattern designed by Mr. J. E. Barnard, F.Inst., F.R.M.S., which permits of the use of any size or shaped filters, or if preferred the U-shaped pattern to take the Wratten filters 2 in. square.

At right angles to the prismatic bench, and attached to the base of lamp hood, is a brass bracket terminating in a rod, which latter fits into a spring socket forming part of a square block. The square block is fitted to and made to slide upon a square upright pillar so as to provide vertical adjustments for the lamp, that it may be raised or lowered to

any desired position. The lamp hood bracket is also provided with a rotary motion that the lamp hood with its components may be inclined to any angle required.

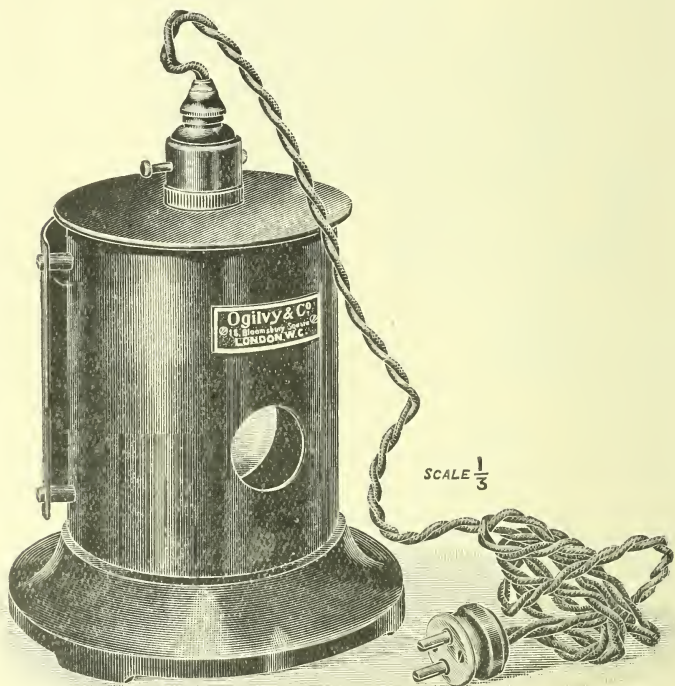


The square upright pillar is mounted upon a widely spread tripod base which gives great rigidity, and is of sufficient weight to prevent

easy displacement of the lamp while the necessary adjustments of the components are being made.

The electric bulb is of the half-watt type, but made of a special mixture of glass which presents an exceedingly fine opal surface. The metallic filament is entirely obscured, the opal glass diffuses the rays emanating from the filament, and when the surface of the glass bulb is sharply focussed in the plane of the object—i.e. the aperture of the iris diaphragm, which is practically in the same plane as the surface of the electric bulb—there is not any structure or granular matter observable in the field of view, consequently no interference with the image of the object; therefore we have an artificial light working under ideal conditions as required in critical illumination. Under these conditions it is claimed that the highest possible efficiency is obtained from the optical system of the microscope. The lamp is made by Ogilvy and Co., 18 Bloomsbury Square, London.

**A New Electric Microscope Lamp for Students' Use and for Routine Laboratory Work.**—Vertical electric lamp, designed to give



the maximum of ventilation with the minimum of reflection. Consisting of cylindrical hood made of planished steel sheet, brass-coated to prevent rusting, mounted upon a heavy cast-iron base having three

bearing points, finished in black lacquer. Fitted with a strongly made push-bar switch and lamp socket, six feet of twin flexible wire, and wall-plug or lamp bayonet fitting. Opalite electric bulb, made of special mixture of glass, which presents a fine opal surface, having no structure or granular matter to interfere with the detail of the object under observation. This bulb is eminently suitable for critical illumination, and is supplied to suit any voltage. The lamp is made by Ogilvy and Co., 18 Bloomsbury Square, London.

### GEOLOGY, ETC.

**Ordovician Lavas of N. Pembrokeshire.**—G. M. PART (*Geol. Mag.*, July, 1922). Six drawings of micro-sections accompany the paper. Most of the specimens are porphyritic with abundant small phenocrysts of felspar. The rest consist of plagioclase of low refractive index.

**Microscopic Determination of Non-opaque Minerals.**—E. S. LARSEN (*U.S. Geol. Survey Bull.*, 679, 1921). Data for refractive indices by immersion are given for some 950 species.

### ULTRAMICROSCOPY, COLLOIDS, ETC.

**Colloids, or the Material of Life.**—S. C. BRADFORD (*Science Progress*, No. 65, July, 1922). In addition to an historical account, the author discusses the application of the ultramicroscope and the importance to industry of catalytic reactions.

**Diffusion in Deformed Gels.**—E. HATSCHKE (*Science Progress*, No. 65, July, 1922). These gels remain isotropic for diffusion under stress. Experimental procedure is discussed.

**The Kinetics of Coagulation.**—J. N. MUKHERJEE and B. C. PAPACONSTANTINOU (*Phil. Mag.*, 44, No. 260, August, 1922). The rate of coagulation is discussed, more particularly with a view to reconciling theory with ultramicroscopic determinations.

**Size of Colloid Particles and Adsorption of Electrolytes.**—H. D. MURRAY (*Phil. Mag.*, 44, No. 260, August, 1922). A cardioid condenser fitted to an ordinary microscope was used instead of an ultramicroscope. Small particles require a higher minimal concentration of electrolyte than large particles.

**Distribution of Particles in Colloidal Suspensions.**—A. W. PORTER and J. J. HEDGES (*Phil. Mag.*, 44, No. 261, Sept., 1922). Countings were taken at various depths. The ultramicroscope was used horizontally, illuminated by a vertical beam. Three distinct layers are recognized in suspensions: (1) A surface layer of thickness comparable with the range of inter-molecular forces. (2) A layer less than 0.1 mm. thick, to which the gas laws can be applied. (3) A layer some 2 mm. thick which gradually merges into the main body of the suspension.

## NOTICES OF NEW BOOKS.

**The Free-living Unarmoured Dinoflagellata.** By Charles Atwood Kofoid and Olive Swezy. Being Vol. V. of the Memoirs of the University of California. 1921. viii + 562 pp., 12 plates, 388 figs. in text. Published by the University of California Press, Berkeley, Cal., U.S.A. Price \$12.50.

The dinoflagellates form a very important part of the deep-sea meadows, the source of the primitive food supply of the sea, both in number of individuals and in the total mass of living substances produced. Until quite recently they were but slightly and imperfectly known, due, in part, perhaps to their absence from all oceanic deposits. Researches, however, which have been carried out on the marine plankton have shown that they abound both in neritic waters and in the high seas, and range from the tropics to the polar oceans. In abundance they are second only to the diatoms, but during their periodic maxima they may far surpass the diatoms in the total mass of organic material produced and in the rapidity of their development. These organisms are the primary and all but universal cause of the discoloured seas and of luminescent waters which are wont to occur in midsummer round our coasts, and more especially in tropic seas. These unicellular organisms may often have a very complex structure, and may also be provided with an armour consisting of a series of plates arranged in a definite pattern which is constant for the species. There is a distinct difference between the apical and the antapical regions of the body and also between the dorsal and ventral faces. Besides these highly organized forms many of a much simpler structure may be obtained by means of the centrifuge—forms in which the cell-wall is poorly developed.

The purpose of this beautiful monograph is to provide a summary of our present knowledge of the naked or unarmoured forms, the most elusive and least known representatives of this group of protozoa. It is based on a study of the marine forms of the San Diego (California) region, made at the biological station of the Scripps Institution for Biological Research. There are 223 species fully described (or re-described) from the point of view of general morphology, histology, physiology, history and distribution; of these no less than 117 are described by the authors for the first time. The monograph is fully provided with text-figures and twelve coloured plates.

The investigation of these extremely delicate organisms is fraught with great difficulty, as a few moments' exposure to the brilliant illumination under the microscope is sufficient to cause cytolysis, and no satisfactory means have yet been devised by which they can be preserved for future examination and study. The investigations have thus been restricted to the rapid examination of freshly captured living material.

For collecting the material the ordinary methods proved of no avail,

and more refined methods had to be adopted, which was only possible where the resources of a biological station such as that at La Jolla are available. A specially devised net of the finest bolting silk is towed for a very short time at a depth of 80 metres; the catch is then transferred to a relatively large volume of water and hurried ashore in a fast motor boat (30 miles an hour), and at once distributed to the microscopes of the observer and his assistants. By this intensive study of living material carried out over a number of years, many very interesting results have been obtained quite apart from the records of new species; results which are of great interest to the biologist. Many of these organisms are very brilliantly coloured, and also show a specialization in structure surprising even in the greatly diversified protozoa.

Of the remarkable "organelles" described by Professor Kofoid as occurring in the dinoflagellates, there are two which are distinctly metazoan in character. In the "ocellus" of the Pouchetiidae we have a structure peculiar to this group alone amongst the protozoa, and in the genus *Erythropsis*, where it attains its highest development, there is a "compact melanosome enclosing a red sensory core at the base of a concentrically laminated spherical lens."

Nematocysts, however, are not restricted to this group of the protozoa, being found throughout the Cnidosporidia and in at least one species of the Ciliata—*Frontonia leucas*. Their origin and presence are described in the genera *Polykrikos* and *Nematodinium*, where the author states that they are "not less specialized than those found in the Coelenterates."

The authors remove the genus *Noctiluca* from the group Cystoflagellata, first defined by Haeckel, and definitely allocate it to the dinoflagellates, placing it in the Gymnodinioidae. *Pyrocystis* is now recognized as an encysted or intermediate stage in the development of the Dinoflagellata; the form *Pyrocystis noctiluca* first described by Murray being but the intermediate stage of *Gymnodinium lunula* Schütt, an almost cosmopolitan species and found in all seas. One of the many interesting biological questions discussed in the introductory part of the monograph concerns the fundamental function of nutrition. In this group of organisms it has not reached that degree of differentiation which enables us to delimit the animal from the plant by this means—holozoic and holophytic nutrition may occur in different species in the same genus. Hence botanists and zoologists will alike continue to regard them as within their several fields of study.

We heartily congratulate the authors on the completion of a very valuable contribution to biological science, one that will prove indispensable to the worker, whether he be engaged in "plankton" research or in oceanography.

To draw particular attention to the few errors that may be detected, mostly proof-reading errors, etc., would be ungracious, but attention should be drawn to one defect which raises a question of some importance, in view of the permanent value of these records—the paper on which the monograph is printed can hardly be described as of a lasting quality.

A. W. SHEPPARD.

# PROCEEDINGS OF THE SOCIETY.

## A CONVERSAZIONE

was held at the Examination Hall, 8-11 Queen Square, Bloomsbury, London, W.C.1, on Wednesday, October 11th, 1922.

A Reception was held by the President, Professor F. J. Cheshire, from 7.45 to 8.15 p.m.

Lantern Demonstrations were given during the evening by—

DR. A. H. DREW.—“Tissue Cultures.”

MR. D. J. SCOURFIELD.—“The Smallest Forms of Pond Life and their biological Significance.”

DR. J. A. MURRAY.—“Microscopic Anatomy of Cancer.”

General Exhibits were shown by—

J. E. BARNARD, F.Inst.P., F.R.M.S., and J. SMILES.—An Experiment with the Abbe Demonstration Microscope.

J. E. BARNARD, F.Inst.P., F.R.M.S., and F. WELCH.—The Leprosy bacillus.

E. W. BOWELL, M.A., M.R.C.S., L.R.C.P., F.R.M.S.—Radulæ of Water Snails.

L. G. GILPIN BROWN, F.R.M.S.—*Trypanosoma gambiense* (The parasite of Sleeping Sickness).

N. E. BROWN.—Structure of cell-wall of *Closterium lineatum*.

REV. CANON G. R. BULLOCK-WEBSTER, F.R.M.S.—Cyclosis in Stem of *Nilrella tenuissima*.

R. W. CHESHIRE, B.A. (Admiralty Research Dept.)—Focometer.

F. W. CHIPPS.—Marine Tube-worm, *Serpula*.

E. CUZNER, F.R.M.S.—Tunicata (Stereo-photo-micrographs).

D. CARDER DAVIES.—Diatoms.

L. S. DAY.—Arranged group of Butterfly scales.

M. T. DENNE, C.B.E., F.R.M.S.—Asellus (Circulation of Blood).

A. EARLAND, F.R.M.S.—Rhizopoda.

J. W. FLOWER, F.R.M.S.—Metallurgical specimens.

G. H. GABB, F.C.S.—Eggs of the Furniture Beetle (*Anobium Domesticum*) in situ.

R. RUGGLES GATES, M.A., Ph.D., F.L.S., F.R.M.S.—*Lactuca chromosomes*.

W. E. HALL, F.R.M.S.—Photomicrographs of complete Transverse Sections of Human foetus.

A. MORLEY JONES.—Diatomaceæ.

R. J. LUDFORD, Ph.D., B.Sc., F.R.M.S.—Preparations illustrating the anatomy of Planarians.

- DR. L. C. MARTIN (Optical Engineering Dept., Imperial College of Science—Technology).—Diffraction in the Microscope.  
 H. W. R. ROOM, F.R.M.S.—*Plumularia echinulata*.  
 F. ROWLEY, F.R.M.S.—Diatoms.  
 J. SARVENT.—Diatoms from the North Sea.  
 C. TIERNEY, M.S., D.Sc., F.R.M.S.—Sample of contaminated Water Supply.  
 H. WOOD, F.C.S.—Sunstone (opaque object).

Trade Exhibits were shown in a special room by—

- J. W. ATHA & Co.—New Zeiss Stands A and B, with Meyer toothed wheel motion. Zeiss Binocular Eyepiece, "Bitumi." Zeiss Siedentopf Change-over Condenser for transmitted and direct ground illumination. New Apochromat "X" for dark ground work.  
 CHARLES BAKER.—Microscopes.  
 R. & J. BECK, LTD.—*Diphtheria bacillus* (dark ground). *Amphi-pleura pellucida* (1/6th in. Apochromatic object glass). *Coscinodiscus* showing pseudopodia, and *Conochilus* showing cilia extended. Microscopes and Apparatus.  
 JOHN BROWNING.—Micro-Polariscope crystals of organic compounds. Cheshire's Thorium Micro-Gas Lamp. Diffraction Grating replicas, etc.  
 THE CAMBRIDGE AND PAUL INSTRUMENT CO., LTD.—Cambridge Rocking Microtome. Cambridge Universal Microtome. Measuring Microscope and Comparator.  
 F. DAVIDSON & Co.—The "Davon" Patent Micro-Telescope. Short focus Micro-Telescope. The "Davon" Super-Microscope and Camera.  
 THE EDISON SWAN ELECTRIC CO., LTD.—Pointolite Lamps and Accessories.  
 FLATTERS & GARNETT, LTD.—Microscopes, Lamps, Microtomes and Accessories.  
 A. GALLenkAMP & Co., LTD.—Microscopes and Microscopical Accessories.  
 G. T. GURR.—Stains and Reagents.  
 HAWKSLEY & SONS.—New Barnard Lamp.  
 ADAM HILGER, LTD.—Interference Attachment for testing Rigidity and Fine adjustment of Microscope Stands. Apparatus for Microscopic examination of Profiles without necessity of Sectioning.  
 KODAK, LTD.—Wratten Filters.  
 OGILVY & Co.—Leitz Microscopes. Combined Mono-Binocular, Binocular, New Greenough Binocular, Portable, Petrological and Metallurgical Microscopes. Sub-stage Condenser Changers. Photomicrographic Apparatus and Microtomes.  
 G. N. PART.—Geological Specimens.  
 RHEINBERG & Co.—Differential Colour Illumination.  
 RUDOLPH & BEESLEY.—Reichert Microscopes and Accessories.

JAMES SWIFT & SON, LTD.—Microscopes.

W. WATSON & SONS, LTD.—Types of Microscopes for all forms of work. Illumination by direct light. Dark Ground and Immersion Paraboloid. New Microscope Gas Illuminant. A New Microscope Substage Illuminator. Microscope Accessories, Apparatus, etc.

Pond Life Exhibits were shown by the following FELLOWS OF THE SOCIETY and Members of the QUEKETT MICROSCOPICAL CLUB—

- S. C. AKEHURST, F.R.M.S.—Polyzoa, *Fredericella sultana*.  
 C. H. BESTOW, F.R.M.S.—*Melicerta ringens*.  
 J. BURTON.—Fresh-water Alga, *Draparnaldia platyzonata*.  
 C. C. CAMPBELL.—*Euglena viridis*  
 F. E. COCKS.—*Dendrosoma radians* Ehr. (rare).  
 R. F. G. COLE.—Rotifers, *Brachionus urceolaris*.  
 R. E. CROSSLAND.—*Melicerta ringens*.  
 A. J. CURWEN.—Desmids (various).  
 B. S. CURWEN.—*Lathonura rectirostris* (a rare Cladocera).  
 D. DAVIES, F.R.M.S.—*Lophopus crystallinus*.  
 F. B. GIBBARD.—Water Mites (various).  
 N. L. GILLESPIE.—Cyclosis in Nitella.  
 H. GOULLEE.—*Argulus foliaceus*.  
 R. J. H. HUNT, F.R.M.S.—*Volvox globator*.  
 H. J. LAWRENCE.—*Fredericella sultana*.  
 R. H. MARCHMENT, F.R.M.S.—*Fredericella sultana*.  
 E. R. MARTIN.—*Epistylis anastatica*.  
 A. MORLEY-JONES.—*Culex pipiens* and Larva.  
 H. H. MORTIMER, F.R.M.S.  
 E. R. NEWMARSH, F.R.M.S.—*Cristatella mucedo*.  
 C. H. OAKDEN, F.R.M.S.—Water Mites, *Arrhenurus crassipetiolatus*.  
 J. M. OFFORD, F.R.M.S.—*Volvox aureus*.  
 R. PAULSON, F.R.M.S.—*Vorticella nebulifera*.  
 J. POLLARD, F.R.M.S.  
 J. RICHARDSON, F.R.M.S.—*Colecheate scutata*.  
 W. RUSSELL.—Spores of Equisetum.  
 D. J. SCOURFIELD, F.R.M.S.—Turbellarian (*Mesostomum* ?).  
 C. D. SOAR, F.R.M.S.—Water Mites, *Arrhenurus caudatus*.  
 C. C. SWATMAN.—Living Diatoms (various).  
 H. TAVERNER, F.R.M.S.—Water Mites (various).  
 B. J. THOMAS.—*Volvox globator* and Larva of Dragon-fly.  
 L. H. TINSON.—*Dinobryon sertularia*.  
 C. TODD.—*Cordylophora lacustris*.  
 E. E. WARR.—Newt Tadpole showing circulation.  
 H. C. WHITFIELD, F.R.M.S.—*Hydra viridis*.  
 H. WILLIAMS.  
 J. WILSON, F.R.M.S.—*Actinospherium eichhornii* and *Closterium kützingerii* with Zygospore.  
 C. L. WITHEYCOMBE.—Larva of *Eristalis pertinax*.  
 H. WOOD, F.C.S.

## AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT NO. 20 HANOVER SQUARE, W., ON  
WEDNESDAY, OCTOBER 18TH, 1922, PROFESSOR F. J. CHESHIRE,  
PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed by the President.

The nomination papers were read of fourteen Candidates for Fellowship.

**New Fellows.**—The following were elected Ordinary Fellows :—

Mr. Robert Allanson.

Mr. Samuel Thomas Denning.

Mr. James Jennison.

Mr. James L. A. Macdonald, D.S.O., D.Sc., F.C.S.

Professor William Maitland, D.Sc.

Major Renold Marx, M.C., B.Sc.

Mr. Arthur Ernest Taylor.

**The Deaths** were announced of—

Sir William Garforth. Elected 1911.

Rev. Dr. Hitchcock. „ 1922.

Mr. J. E. Minns. „ 1907.

On the motion of the **President** those present rose in their places as a mark of sympathy with the relatives.

**Donations** was reported from :—

Lady Woodhead. Three microscopes.

Librarie Felix Alcan. “ L'Organisation de la Matière.”

Religious Tract Society. “ The Microscope.” (Wright & Drew.)

Longmans, Green & Co. “ Chemistry of Plant Products,” Vol. II.

Thanks were accorded to the donors.

**Dr. Murray** read a report prepared by the Curator, Mr. W. E. Watson Baker, on the three microscopes, the property of the late Professor Sir G. Sims Woodhead, Past-President of the Society, which had been presented to the Society's collection by Lady Sims Woodhead.

The microscopes are of three distinct types, two of which present

features that are not present on other microscopes in the Society's collection.

The first is an Andrew Ross, a very old model, with a plain stage having a sliding plate, a wheel diaphragm, two capped eye-pieces, objectives 1 in. and  $\frac{1}{4}$  in.

The next instrument, by Smith, Beck & Beck, has the flat form of foot to be found on many of Messrs. Beck's stands of that period, a foot which is particularly rigid. It is provided with coarse and fine adjustments, plain stage with sliding object carrier, underfitting ring with wheel diaphragm, while the accessory apparatus consists of a double nose-piece, an erector, two capped eye-pieces, objectives  $\frac{2}{3}$  in. and  $\frac{1}{2}$  in., and three dark ground stops. Attention must be called to the fine adjustment on this instrument. There is not such another fine adjustment in the collection. The milled head exerts a direct pull from the under surface on the pillar supporting the microscope body, and it would appear that this principle must have been the parent of the micrometer fine adjustment, either by direct acting screw or against a spring introduced at a later date by the Germans.

The third instrument is made by James Swift, and represents an exceptionally complete outfit. The stand has been developed not only for petrological, but for ordinary biological purposes. It is interesting here to note that both the analyser and binocular prisms are removable at will, and for use as a monocular a separate tube replaces the binocular drawtube. This, instead of being cut away, as is the method with the binocular microscopes, is solid throughout its length, thus preventing any stray light, and it projects beyond the length of the ordinary tube in order that no confusion may arise. The rotating stage has a rackwork movement, and the rotation divisions are on silver. A mechanical stage is provided with sliding bar, and here again the divisions are on silver. The substage is of the rack focussing and screw centring type, while centring screws are fitted to the stage. The combined condenser, which appears to be of the Webster achromatic type, and the polarizer, were probably introduced by Messrs. Swift, and special attention should be given to the iris diaphragm, which is a very early one and well made. The condenser has rotating cells for the selenites and mica dark ground stops, a pin-hole disc, glass discs, two selenites, and one  $\frac{1}{4}$ -wave plate mica. In addition to this, the accessories with the instrument comprise: one micrometer eye-piece with micrometer, three pairs of capped eye-pieces, one each capped eye-pieces D and F, one quadruple nose-piece, one Bertrand's lens, and frog plate. The objectives are Messrs. Swift's best series, the powers being  $\frac{1}{2}$  in.,  $\frac{1}{4}$  in.,  $\frac{1}{8}$  in., and  $\frac{1}{16}$  in. immersion. All are provided with correction collars.

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Mr. Conrad Beck exhibited a new and inexpensive microscope, in waterproof canvas case, and was thanked for his exhibit.

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A paper by Mr. S. C. Akehurst, "Larva of *Chaoborus crystallinus* (De Geer) (*Corethra plumicornis* F.)," was read in title.

The following papers were read and discussed :—

Professor Robert Chambers (communicated by Professor R. Ruggles Gates, M.A., Ph.D., F.R.M.S.)—

“New Apparatus and Methods for the Dissection and Injection of Living Cells.”

Mr. Thomas F. Connolly, M.B.E., M.Sc., F.Op.S., F.R.M.S. (Inspector of Scientific Supplies, India Office)—

“The Specification of a Medical Microscope.”

Hearty votes of thanks were accorded to the authors of the above papers and to Professor R. Ruggles Gates.

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The business proceedings then terminated.

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## AN ORDINARY MEETING

OF THE SOCIETY WAS HELD AT 20 HANOVER SQUARE, W., ON  
WEDNESDAY, NOVEMBER 15TH, 1922, PROFESSOR F. J. CHESHIRE,  
PRESIDENT, IN THE CHAIR.

The Minutes of the preceding Meeting were read, confirmed, and signed by the President.

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The nomination papers were read of five Candidates for Fellowship.

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**New Fellows :—**The following were elected Ordinary Fellows of the Society :—

Mr. Norman James Bidlake.  
Mr. Reginald Arthur Bray, M.A.  
Mr. Arthur L. Butler.  
Mr. William Frederic Charles.  
Mr. Herbert T. A. Cook.  
Mr. Norman Oliver Edwards, A.B.S.A.  
Mr. George Walker Gosling.  
Mr. Herbert Hobson, F.C.S.  
Mr. Leonard Stanley Hodgson.  
Mr. Hamid Khan, M.Sc.  
Mr. Herbert Pearce.  
Mr. Peshotan Dadabhoy Shroff, B.Sc.  
Mr. Walter Simpson.  
Mr. James Suttie.

The Death was announced of Miss Mary A. Booth, elected 1889, and a vote of sympathy with her relatives was passed.

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Donations were reported from :—

Mr. G. N. E. Hall-Say. A microscope, formerly the property of Mr. Edward Evans.

Messrs. Benn Bros., Ltd. "Practical Optics" (B. K. Johnson).

M. Paul Lechevalier. "Faune de France," Vols. III. and IV.

Mr. R. Schmechlik. "Die Anwendung des Mikroskops."

Thanks were accorded to the donors.

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The following papers were read in title :—

Professor Ekendranath Ghosh, M.Sc., M.D.—

"A New Species of Scyphidia."

"Notes on *Arcella vulgaris*."

Mr. A. Subba Rau, B.A., F.R.M.S., and Dr. J. Bronté Gatenby, B.A., D.Ph., D.Sc., F.R.M.S.—

"Distribution, Morphology and Cytology of the Organ of Bidder."

The following papers were read and discussed :—

Mr. Conrad Beck, O.B.E., F.R.M.S.—

"Glare and Flooding in Microscope Illumination."

Mr. Charles Singer, M.D., D.Litt., F.R.C.P., F.R.M.S.—

"The First Mechanical Microtome."

"The First Microscopical Drawings."

Professor Gobind Singh Thapar, M.Sc., F.R.M.S.—

"The Occurrence and Significance of a Third Contractile Vacuole in *Paramecium caudatum*."

Professor B. L. Bhatia, M.Sc., F.Z.S., F.R.M.S.—

"On the Significance of Extra Contractile Vacuoles in *Paramecium caudatum*."

Hearty votes of thanks were accorded to the authors of the above papers.

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The business proceedings then terminated.

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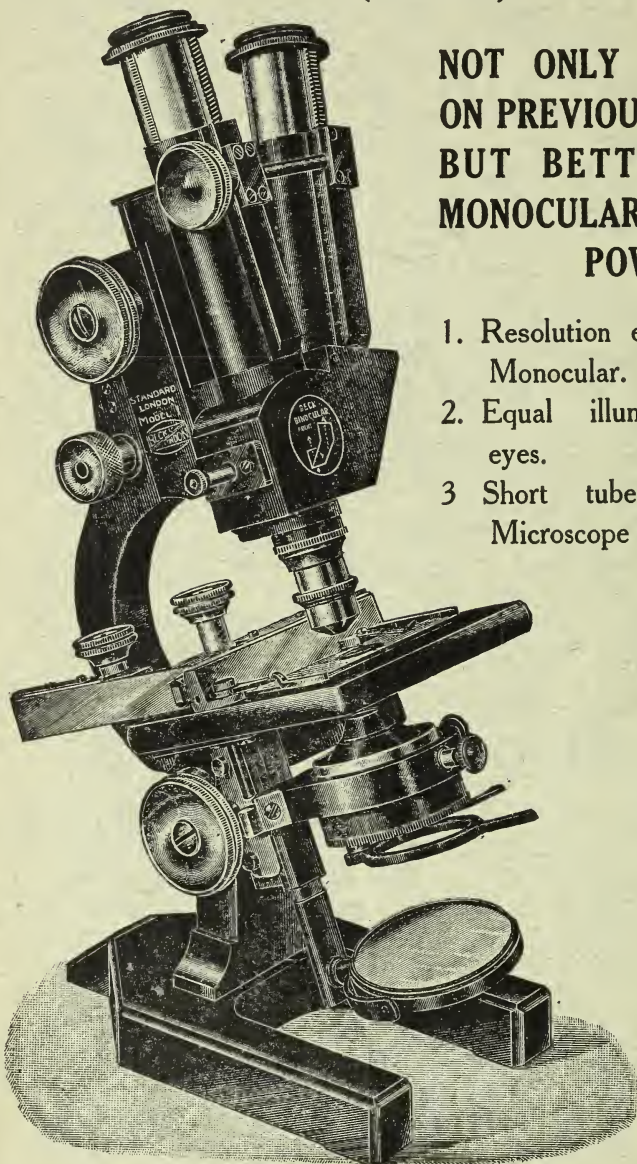
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APERTURE TABLE.

Numerical Aperture. sine $u = N A$	Corresponding Angle $2u$ for			Limit of Resolving Power, in Lines to an Inch.			Illuminating Power. ( $NA$ ) <sup>2</sup>	Pene- trating Power. $\frac{1}{NA}$
	Air $n = 1.00.$	Water $n = 1.33.$	Homogeneous Immersion $n = 1.615.$	White Light. $\lambda = 0.5607 \mu$ (Between D and E).	Monochromatic Blue Light. $\lambda = 0.4361 \mu$ (Line F).	Photography. $\lambda = 0.4341 \mu$ (Line Hy).		
1.515	..	..	180° 0'	137,672	158,845	177,822	2.310	.658
1.51	..	..	170° 41'	136,766	157,800	176,652	2.280	.662
1.50	..	..	163° 52'	135,860	156,755	175,482	2.250	.667
1.49	..	..	159° 9'	134,955	155,710	174,312	2.220	.671
1.48	..	..	155° 19'	124,049	154,665	173,143	2.190	.676
1.47	..	..	152° 0'	133,143	153,620	171,973	2.161	.680
1.46	..	..	149° 2'	132,237	152,575	170,803	2.132	.685
1.45	..	..	146° 19'	131,332	151,530	169,633	2.103	.690
1.44	..	..	143° 48'	130,426	150,485	168,463	2.074	.694
1.43	..	..	141° 26'	129,520	149,440	167,293	2.045	.694
1.42	..	..	139° 12'	128,614	148,395	166,123	2.016	.709
1.41	..	..	137° 5'	127,709	147,350	164,953	1.988	.709
1.40	..	..	135° 4'	126,803	146,305	163,783	1.960	.714
1.39	..	..	133° 7'	125,897	145,260	162,614	1.932	.719
1.38	..	..	131° 16'	124,991	144,215	161,444	1.904	.725
1.37	..	..	129° 27'	124,086	143,170	160,274	1.877	.729
1.36	..	..	127° 43'	123,180	142,125	159,104	1.850	.735
1.35	..	..	126° 1'	122,274	141,080	157,934	1.823	.741
1.34	..	..	124° 23'	121,369	140,035	156,764	1.796	.746
1.33	..	180° 0'	122° 47'	120,463	138,989	155,594	1.769	.752
1.32	..	165° 56'	121° 13'	119,557	137,944	154,424	1.742	.758
1.30	..	155° 38'	118° 12'	117,746	135,854	152,085	1.690	.769
1.28	..	148° 42'	115° 19'	115,934	133,764	149,745	1.638	.781
1.26	..	142° 39'	112° 33'	114,123	131,674	147,405	1.588	.794
1.24	..	137° 36'	109° 52'	112,311	129,584	145,065	1.538	.806
1.22	..	133° 4'	107° 16'	110,500	127,494	142,726	1.488	.820
1.20	..	128° 55'	104° 46'	108,688	125,404	140,386	1.440	.833
1.18	..	125° 3'	102° 19'	106,877	123,314	138,046	1.392	.847
1.16	..	121° 26'	99° 56'	105,065	121,224	135,706	1.346	.862
1.14	..	118° 0'	97° 37'	103,254	119,134	133,367	1.300	.877
1.12	..	114° 44'	95° 20'	101,442	117,044	131,027	1.254	.893
1.10	..	111° 36'	93° 7'	99,631	114,954	128,687	1.210	.909
1.08	..	108° 36'	90° 56'	97,819	112,864	126,347	1.166	.926
1.06	..	105° 42'	88° 48'	96,008	110,774	124,008	1.124	.943
1.04	..	102° 53'	86° 42'	94,196	108,684	121,668	1.082	.962
1.02	..	100° 10'	84° 38'	92,385	106,593	119,328	1.040	.980
1.00	180° 0'	97° 31'	82° 37'	90,574	104,503	116,988	1.000	1.000
0.98	157° 2'	94° 56'	80° 37'	88,762	102,413	114,648	.960	1.020
0.96	147° 29'	92° 24'	78° 38'	86,951	100,323	112,309	.922	1.042
0.94	140° 6'	89° 56'	76° 42'	85,139	98,223	109,969	.884	1.064
0.92	133° 51'	87° 32'	74° 47'	83,328	96,143	107,629	.846	1.087
0.90	128° 19'	85° 10'	72° 53'	81,516	94,053	105,289	.810	1.111
0.88	123° 17'	82° 51'	71° 1'	79,705	91,963	102,950	.774	1.136
0.86	118° 38'	80° 34'	69° 10'	77,893	89,873	100,610	.740	1.163
0.84	114° 17'	78° 20'	67° 21'	76,082	87,783	98,270	.706	1.190
0.82	110° 10'	76° 8'	65° 32'	74,270	85,693	95,930	.672	1.220
0.80	106° 16'	73° 58'	63° 45'	72,459	83,603	93,591	.640	1.250
0.78	102° 31'	71° 49'	61° 58'	70,647	81,513	91,251	.608	1.282
0.76	98° 56'	69° 42'	60° 13'	68,836	79,423	88,911	.578	1.316
0.74	95° 28'	67° 37'	58° 29'	67,024	77,333	86,571	.548	1.351
0.72	92° 6'	65° 32'	56° 45'	65,213	75,242	84,232	.518	1.389
0.70	88° 51'	63° 31'	55° 2'	63,401	73,152	81,892	.490	1.429
0.68	85° 41'	61° 30'	53° 20'	61,590	71,032	79,552	.462	1.471
0.66	82° 36'	59° 30'	51° 39'	59,779	68,922	77,212	.436	1.515
0.64	79° 36'	57° 31'	49° 59'	57,967	66,882	74,872	.410	1.562
0.62	76° 38'	55° 34'	48° 19'	56,156	64,792	72,533	.384	1.613
0.60	73° 44'	53° 38'	46° 40'	54,344	62,702	70,193	.360	1.667
0.58	70° 54'	51° 42'	45° 1'	52,533	60,612	67,853	.336	1.724
0.56	68° 6'	49° 48'	43° 23'	50,721	58,522	65,513	.314	1.786
0.54	65° 22'	47° 54'	41° 46'	48,910	56,432	63,174	.292	1.852
0.52	62° 40'	46° 2'	40° 9'	47,098	54,342	60,834	.270	1.923
0.50	60° 0'	44° 10'	38° 32'	45,287	52,252	58,494	.250	2.000
0.45	53° 30'	39° 33'	34° 34'	40,758	47,026	52,445	.203	2.222
0.40	47° 9'	35° 0'	30° 37'	36,229	41,801	46,795	.160	2.500
0.35	40° 58'	30° 30'	26° 43'	31,701	36,576	40,946	.123	2.857
0.30	34° 56'	26° 4'	22° 50'	27,172	31,351	35,096	.090	3.333
0.25	28° 58'	21° 40'	19° 0'	22,643	26,126	29,247	.063	4.000
0.20	23° 4'	17° 18'	15° 10'	18,115	20,901	23,398	.040	5.000
0.15	17° 14'	12° 58'	11° 22'	13,586	15,676	17,548	.023	6.667
0.10	11° 29'	8° 38'	7° 34'	9,057	10,450	11,699	.010	10.000
0.05	5° 44'	4° 18'	3° 47'	4,529	5,252	5,849	.003	20.000

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# Royal Microscopical Society.

## CHARTER AND BY-LAWS.

---

### CHARTER.

Victoria, by the Grace of God of the United Kingdom of Great Britain and Ireland, Queen, Defender of the Faith, To ALL TO WHOM THESE PRESENTS SHALL COME GREETING: WHEREAS James Scott Bowerbank, Doctor of Laws, Fellow of the Royal Society; Rev. Joseph Bancroft Reade, Master of Arts, Fellow of the Royal Society; Nathaniel Bagshaw Ward, Fellow of the Royal Society; and others of our loving subjects, did, in the year 1839, establish a Society by the name of "THE MICROSCOPICAL SOCIETY OF LONDON," for the advancement of Microscopical Science:

AND WHEREAS it has been represented to us that the same Society has, since its establishment, sedulously pursued such its proposed object, by the researches of its members, and the collection and discussion of observations, and by the publication of its transactions from time to time, which have contributed to the progress of Microscopical knowledge:

AND WHEREAS distinguished individuals in foreign countries, as well as British subjects, have availed themselves of the facilities offered by the same Society for communicating important discoveries, greatly extending Microscopical knowledge; and the great and general interest now felt in those branches of Science, whereof the Microscope is an important instrument of investigation, has been greatly promoted and fostered by this Society:

AND WHEREAS the same Society has, in aid of its objects, acquired a considerable and important Library of Scientific Works, a large collection of Microscopic objects, and several valuable Microscopes, to which fresh accessions are constantly being made; and the said Society has hitherto been supported by donations and annual and other subscriptions and contributions to its funds, and has therefrom purchased and is possessed of a considerable amount of stock in the public funds:

AND WHEREAS, in order to secure the property of the said Society, to extend its operations, and to give it a more permanent establish-

ment among the scientific institutions of our kingdom, we have been besought to grant to James Glashier, Fellow of the Royal Society, the present President of the said Society, and to those who now are or shall hereafter become members of the said Society, our Royal Charter of Incorporation for the purposes aforesaid :

NOW KNOW YE THAT WE, being desirous of encouraging a design so laudable and salutary, of our especial grace, certain knowledge, and mere motion, have willed, granted, and declared, and do by these presents, for us, our heirs and successors, will, grant and declare that the said James Glashier, and such other of our loving subjects as now are members of the said Society, or shall from time to time be elected Fellows thereof, according to such regulations or by-laws as shall be hereafter framed or enacted, and their successors shall for ever hereafter be by virtue of these presents one body politic and corporate, by the name of "The Microscopical Society of London"; \* and for the purposes aforesaid, and by the name aforesaid, shall have perpetual succession and a common seal, with full power and authority to alter, vary, break, and renew the same at their discretion, and by the same name to sue and be sued, implead and be impleaded, answer and be answered, unto and in every court of us, our heirs and successors, and be for ever able and capable in the law to purchase, receive, possess, hold and enjoy, to them and their successors, any goods and chattels whatsoever, and also to be able and capable in the law (notwithstanding the Statute of Mortmain) to take, purchase, hold, and enjoy to them and their successors a hall or house, and any such messuages, lands, tenements, or hereditaments whatsoever as may be necessary or expedient for carrying out the purposes of the Society, the yearly value of which, including the site of the said hall or house, shall not exceed in the whole the sum of 1000*l.*, computing the same respectively at the time of the purchase or acquisition thereof, and to act in all the concerns of the said body politic and corporate as effectually, to all intents and purposes, as any other of our liege subjects, or any other body politic or corporate in our said kingdom, not being under any disability, might do in their respective concerns.

And we do hereby grant our special licence and authority unto all and every person and persons, bodies politic and corporate (otherwise competent), to grant, sell, alien and convey in mortmain unto and to the use of the said body politic and corporate and their successors any messuages, lands, tenements, or hereditaments not exceeding such annual value as aforesaid.

And our will and pleasure is, and we further grant and declare, that there shall be a General Meeting or General Meetings of the

\* On the 1st November, 1866, Mr. Secretary Walpole notified to the President that Her Majesty had been graciously pleased "to command that the Society shall be styled the Royal Microscopical Society."

Fellows of the said Society to be held from time to time as hereinafter mentioned, and that there shall be a Council to direct and manage the concerns of the said body politic and corporate, and that the General Meetings and the Council shall have the entire direction and management of the same in the manner and subject to the regulations hereinafter mentioned.

And we do hereby also will, grant, and declare that there shall be a President, Vice-Presidents, a Treasurer, and Secretaries of the said body politic and corporate, and that the Council shall consist of the President, Vice-Presidents, Treasurer, Secretaries, and not more than twelve nor less than eight other Fellows of the said Society.

And we do hereby further will and declare that the said James Glaisher shall be the first President of the said body politic and corporate, and the other persons now being the Vice-Presidents, Treasurer, Secretaries, and Members of the Council shall be first Members of the Council, and shall continue such until the election of officers shall be made in pursuance of these presents.

And we do hereby further will and declare that it shall be lawful for the Fellows of the said body politic and corporate hereby established to hold a General Meeting once in the year or oftener, for the purposes hereinafter mentioned; namely, that the President, Vice-Presidents, the Treasurer, the Secretaries, and other Members of the Council, shall be chosen at such General Meeting, and that the General Meetings shall from time to time make and establish such by-laws, and vary and alter or revoke the same as they shall deem to be useful and necessary for the regulation of the said body politic and corporate, for the admission of Fellows and of Honorary and Foreign Members, and for the fixing the number of the Vice-Presidents and Officers, and for the management of the proceedings, and the estates, goods, and business of the said body politic and corporate, so that such by-laws be not repugnant to these presents, or to the laws and statutes of this our realm, and shall and may also enter into any resolution and make any regulation respecting the affairs of the said body politic and corporate that may be necessary and proper:

And we do further will and declare that the General Meetings shall take place at such time as may be fixed by the said Council, and that the present regulations of the said Society, so far as they are not inconsistent with these presents, shall continue in force until the same shall be altered by a General Meeting.

And we further will, grant, and declare that the Council shall have the sole management of the income and funds of the said body politic and corporate, and the appointment of librarian, curator, and such other officers, attendants, and servants as the Council shall think necessary or useful, as also the entire management and superin-

tendence of all the other affairs of the said Society, and shall and may, but not inconsistently with or contrary to the provisions of this our Charter, or any existing by-law, or the laws and statutes of this our realm, do all such acts and deeds as shall appear to them necessary for carrying into effect the objects and views of the said body politic and corporate.

PROVIDED ALWAYS, and we do will and declare that the Council shall, from time to time, render to a General Meeting a full account of their proceedings, and that every Fellow of the Society may at all reasonable times, to be fixed by the said Council, see and examine the accounts of the receipts and payments of the said body politic and corporate.

And we further will, grant, and declare that the whole property of the said body politic and corporate shall be vested, and we do hereby vest the same, solely and absolutely in the Fellows thereof, and that they shall have full power and authority to sell, alienate, charge, and otherwise dispose of the same as they shall think proper, but that no sale, mortgage, incumbrance, or other disposition of any messuages, lands, tenements, or hereditaments belonging to the said body politic and corporate shall be made, except with the approbation and concurrence of a General Meeting.

AND WE LASTLY DECLARE it to be our Royal will and pleasure that no resolution or by-law shall, on any account or pretence whatsoever, be made by the said body politic and corporate, in opposition to the general scope, true intent, and meaning of this our Charter, or the Laws or Statutes of our Realm: And that if any such rule or by-law shall be made, the same shall be absolutely null and void to all intents, effects, constructions and purposes whatsoever.

IN WITNESS WHEREOF we have caused these our Letters to be made Patent.

WITNESS OURSELF, at our Palace at Westminster, this twenty-eighth day of August in the thirtieth year of our reign.

BY HER MAJESTY'S COMMAND.

(Signed) CARDEW.

# BY-LAWS.

*As revised at a Special General Meeting held on the  
21st December, 1921.*

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## I. Objects.

1. The Objects of the Society are the promotion of Microscopical and Biological Science by the communication, discussion, and publication of Observations and Discoveries relating to (1) Improvements in the Construction and mode of Application of the Microscope, or (2) Biological or other subjects of Microscopical Research.

## II. Constitution.

2. The Society shall consist of Ordinary, Honorary, and Ex-officio Fellows, without distinction of sex.

3. The number of Ordinary Fellows shall not be limited. The number of Honorary Fellows shall be limited to fifty, and of Ex-officio Fellows to one hundred.

## III. Management.

4. The management of the Society's property and affairs shall be vested in a Council consisting of twenty Members, viz.:—Eight Officers (a President, four Vice-Presidents, a Treasurer, and two Secretaries) and twelve other Ordinary Fellows (hereinafter referred to as "Ordinary Members of Council").

## IV. Fellows.

### A. Election.

#### (a) Ordinary Fellows.

5. Every candidate desirous of being elected an Ordinary Fellow must be proposed by three or more Ordinary Fellows who must sign a certificate setting forth his names, place of residence, and description. The Fellow whose name stands first upon the certificate, must have personal knowledge of the candidate. In cases which the Council regard as exceptional, the Council shall have power to dispense with this provision.

6. The certificate shall be read by the President, Vice-President, or other Chairman, or one of the Secretaries at the General Meeting next after its receipt, and shall then be suspended in one of the rooms of the Society, and shall be read a second time at the next succeeding General Meeting.

7. The votes on any election of Ordinary Fellows shall be taken by ballot.

8. The ballot shall take place at the General Meeting at which the certificate shall have been read for the second time. No ballot shall be valid unless ten or more votes are recorded; and when at least two-thirds of the votes are in favour of the candidate, he shall be declared duly elected.

9. The Secretaries shall send a notice of election, together with a copy of these By-Laws, to every Ordinary Fellow so elected.

10. Every person elected an Ordinary Fellow shall sign the following form of declaration, and shall pay the admission fee and first annual subscription within two months from the date of election or within such further time as the Council may allow. In default of such signature and payment the election of such Fellow shall be void.

*I, the undersigned, having been elected a Fellow of the ROYAL MICROSCOPICAL SOCIETY, hereby agree that I will be governed by the Charter and By-Laws of the Society for the time being; and that I will advance the objects of the Society as far as shall be in my*

power, and will not use the Fellowship for the purpose of advertisement in trade or business. Provided that when I shall signify in writing to one of the Secretaries that I am desirous of ceasing to be a Fellow thereof, I shall (after payment of all annual subscriptions that may be due from me, and returning any books, or other property belonging to the Society in my possession) be free from this obligation.

Witness my hand the                      day of                      19     .

(b) *Honorary Fellows.*

11. Any person eminent in Microscopical or Biological Science shall be eligible for election as an Honorary Fellow.

12. Such person must be proposed by five or more Ordinary Fellows, who must sign a certificate setting forth his names, place of residence, and description, and stating that he is eminent in Microscopical or Biological Science, and that they have a personal knowledge of him or are acquainted with his works.

13. The certificate shall be laid before the Council, and if they approve of the person named therein, shall be read and suspended, and the ballot for such person shall take place in the same manner as is hereinbefore provided for the election of Ordinary Fellows.

14. The Secretaries shall send a notice of election, together with a copy of these By-Laws, to every Honorary Fellow so elected.

(c) *Ex-Officio Fellows.*

15. The President for the time being of any Society having objects in whole or in part similar to those of this Society, shall be eligible for election as an Ex-officio Fellow.

16. Such person must be proposed by ten or more Ordinary Fellows, who must sign a certificate setting forth his names, place of residence, and description, and the name of the Society of which he is President.

17. The certificate shall be laid before the Council, and if they approve of the person named therein, shall be read and suspended, and the ballot for such person shall take place in the same manner as is hereinbefore provided for the election of Ordinary Fellows.

18. The Secretaries shall send a notice of election, together with a copy of these By-Laws, to every Ex-officio Fellow so elected.

19. On any Ex-officio Fellow ceasing to be President of such Society as aforesaid, his successor shall *ipso facto* become an Ex-officio Fellow, unless the Council shall otherwise resolve, in which case such successor must be proposed for election and balloted for in manner provided in Arts. 16 and 17.

B. *Admission Fee, Annual Subscription, and Composition.*

20. Every Ordinary Fellow shall pay an admission fee of two guineas, or such other sum as may be determined from time to time by the Council, and a further sum of two guineas as an annual subscription.

21. The annual subscription shall be due on election and thereafter in advance on the 1st of January in each year.

22. Ordinary Fellows elected in March or April in any year shall be exempted from payment of one-sixth of the annual subscription for that year; those elected in May or June, in October, or in November or December, shall be exempted from payment of two-sixths, four-sixths, and five-sixths respectively of such subscription, according to the month in which they are elected.

23. Any Ordinary Fellow who may permanently reside out of the United Kingdom shall be exempted from payment of one-fourth of the annual subscription; and any Ordinary Fellow who may be absent from the United Kingdom during the whole of one year, shall, upon notifying the fact to one of the Secretaries in writing, be similarly exempted during such year.

24. The Council may remit all or part of the past or future annual subscriptions of any Ordinary Fellow if they shall think desirable, but the reason for such remission shall be stated in the resolution by which it is granted.

25. Every Ordinary Fellow who may desire to compound for his annual subscriptions may do so by a payment of thirty guineas; or, if permanently residing out of the United Kingdom, by a payment of three-fourths of such sum. If such last-mentioned Fellow shall subsequently come to reside within the United Kingdom, he shall forthwith pay the remaining one-fourth of such sum.

26. Honorary and Ex-officio Fellows shall not be liable to pay any admission fee or annual subscription.

### *C. Privileges.*

27. All Ordinary Fellows shall be entitled to propose candidates for election as Fellows; to be elected, and to nominate Fellows for election, as Members of the Council or as Officers; to introduce one visitor at any General Meeting; to receive the publications of the Society; and to inspect and use the books, instruments, and other property of the Society, under such regulations as the Council may from time to time determine. All Ordinary Fellows shall have the right to be present, to state their opinion, and to vote at all General Meetings. Fellows shall have the right to place the letters F.R.M.S. after their names for so long as they remain Fellows of the Society.

28. No Ordinary Fellow shall vote on any occasion, or be entitled to any of the privileges of a Fellow, until he has signed the declaration and made the payments mentioned in Art. 10, nor if his annual subscription is twelve months in arrear.

29. Honorary Fellows and Ex-officio Fellows shall have all the privileges of Ordinary Fellows, except those of proposing candidates for election as Fellows, being elected and nominating Fellows for election as Members of the Council or as Officers, receiving the publications of the Society, and voting at General Meetings.

### *D. Withdrawal and Removal.*

30. Any Fellow may withdraw from the Society after having paid all annual subscriptions due from him, returned any books or other property belonging to the Society in his possession, and given written notice to one of the Secretaries of his desire to withdraw.

31. The Council may remove any Ordinary Fellow from the Society whose annual subscription shall be more than two years in arrear, but before removing him shall serve him with a notice stating the amount of his arrears, and that in the event of non-payment thereof within twenty-eight days he will be liable to be so removed. Such removal shall not prejudice the right of the Society to recover the arrears at any time thereafter.

32. Any Ordinary Fellow who shall have been removed under the provisions of Art. 31 may, on payment of all arrears, be reinstated by the Council.

33. Whenever there may be any other cause to remove any Fellow from the Society, the Council shall propose a resolution to that effect, which shall be read at two successive General Meetings, and suspended in the interval in one of the rooms of the Society. At the second of such meetings a ballot shall be taken, and if two-thirds of the votes shall be in favour of the removal of such Fellow he shall be removed from the Society accordingly.

## **V. Council.**

### *A. Election.*

34. The Council shall be elected at the Annual Meeting in each year, at which Meeting all the Members of the Council shall retire from office.

35. The President and Vice-Presidents shall be ineligible for election to their respective offices for more than two years in succession, and four of the twelve Ordinary Members of Council shall in each year be ineligible for re-election as such Ordinary Members.

36. The Council at their meeting in November, shall prepare a list of Fellows to be recommended to the Society for election at the ensuing Annual Meeting, which list shall be read at the General Meeting in December.

37. Any three or more Fellows who shall be desirous of nominating any other Fellow for election, may do so by delivering a nomination paper to the Secretaries, duly signed, before the close of such General Meeting.

38. The votes on any election of the Council shall be taken by ballot.

39. The names of all the Fellows nominated shall be printed in one balloting paper, which shall state by whom the nominations are made.

40. Any Fellow may erase any name from the balloting paper, and may insert in place thereof the name of any other duly qualified Fellow.

41. If for any reason a new Council shall not be elected at the Annual Meeting, the Council for the time being shall continue in office for the year ensuing, or until a new Council shall be elected by a Special General Meeting, and if the place of any Officer or Ordinary Member of Council is not filled up the Council shall have power to fill such vacancy.

42. If in the interval between any two Annual Meetings the place of any Officer or Ordinary Member of Council shall become vacant, the Council shall have power to fill such vacancy.

### *B. Proceedings.*

43. The Council shall hold their Meetings at such times as they may appoint.

44. Meetings may be called at any time by the President or by three other Members.

45. Five Members shall constitute a quorum, and if within half an hour from the time appointed for the Meeting a quorum be not present, the Meeting shall be dissolved.

46. In the absence of the President and Vice-Presidents from any meeting, the Members shall choose one of their number to take the Chair, and such Member shall, for the time being, have all the authority and privileges of the President.

47. The votes on any question before the Council shall be by show of hands, unless a ballot shall be demanded by any two Members.

48. The decision of the majority of Members voting at any Meeting shall be considered as the decision of the Meeting.

49. The Council may, from time to time, appoint any Fellows of the Society, whether Members of the Council or not, to be a Committee to deal with any matter referred to it. Every such Committee shall conform to any regulations that may be imposed on it by the Council.

50. No resolution of the Council shall be rescinded by a subsequent Meeting, unless notice of the intention to propose such rescission shall have been sent to the Members one week prior to the subsequent Meeting.

51. The common seal of the Society shall not be affixed to any document, except at a meeting of the Council and pursuant to a resolution duly passed thereat; and such document shall then be signed by the President, Vice-President, or other Chairman of such meeting, and by one of the Secretaries.

52. At the commencement of each year the Council shall prepare a Report on the affairs of the Society for the preceding year.

53. The Society shall not make any dividend, gift, division, or bonus unto or between any of its Members.

*C. Special.*

54. The Council may concur with any other learned Society in promoting any object embracing the advancement of Microscopical and Biological Science upon such terms as the Council may consider advantageous to the Society.

**VI. Officers.***A. President and Vice-Presidents.*

55. The President shall take the Chair at all meetings of the Society or Council, and shall regulate the proceedings thereat. He shall be a member of all Committees appointed by the Council or by any General Meeting.

56. In the case of an equality of votes at any Meeting, the President shall be entitled to a second or casting vote.

57. In the absence of the President from any Meeting, it shall be the duty of one of the Vice-Presidents to take the Chair, and he shall for the time being have all the authority and privileges of the President.

*B. Treasurer.*

58. The Treasurer shall be a Member of all Committees appointed by the Council, or by any General Meeting. He shall receive all moneys due to the Society, and shall pay therefrom only such amounts as may be ordered by the Council.

59. All moneys received by the Treasurer shall be paid by him to the Society's Bankers, a sum not exceeding 20*l.* being retained for the payment of current expenses.

60. The Treasurer shall keep in appropriate books proper and sufficient accounts in all necessary detail of the capital funds and expenditure of the Society so that the true financial state and condition of the Society may be at all times exhibited by such accounts.

61. The Treasurer shall lay before the Council at their meeting in January a list of all Ordinary Fellows in arrear of their annual subscriptions.

62. The accounts shall be audited annually by a professional Accountant to be appointed by the Council. Such Accountant shall have power of calling for all necessary books, papers, vouchers and information.

63. The account so audited shall be signed by the Auditors, and laid before the next succeeding Annual Meeting.

*C. Secretaries, Librarian and Curator.*

64. The Secretaries shall be Members of all Committees appointed by the Council, or by any General Meeting. They shall take, or cause to be taken, minutes of the proceedings of all Meetings, and produce and read them at the ensuing Meetings; they shall conduct the business and correspondence of the Society; and shall discharge all such other duties as are usually discharged by Secretaries of Scientific Societies.

65. The Council shall, at the Annual Meeting, propose a Fellow of the Society to act as Librarian. He shall be elected by the Society. He shall have the care of all the books, MSS. and journals of the Society, and the management thereof, subject to the control of the Library Committee and of the Council. He shall make and keep up a catalogue of the documents under his charge, and shall make an annual report to the Council as to their condition.

66. The Council shall at the Annual Meeting, propose a Fellow or Fellows of the Society to act either separately or jointly as Curator or Curators of the instruments, tools, and such other property belonging to the Society as may from time to time be confided by the Council to his or their care. They shall be elected by the Society. They shall make and keep a catalogue or catalogues of all the property under their charge respectively, and shall make an annual report or reports to the Council as to the state of such property.

67. The Council may appoint an Assistant Secretary, and assign to him such duties as it may think desirable, at such remuneration as it may deem proper.

## VII. General Meetings.

68. The General Meetings shall be of three kinds—Ordinary, Annual, and Special.

69. Ten Ordinary Fellows shall constitute a quorum, and if within half an hour from the time appointed for the Meeting a quorum shall not be present, the Meeting shall be dissolved.

70. In the absence of the President and Vice-Presidents, the Members of Council present shall choose one of their number to take the Chair, or if no such member shall be present, the Meeting may elect any Ordinary Fellow present to take the Chair, and the Fellow so presiding shall for the time being have all the authority and privileges of the President.

71. All votes shall be taken by show of hands, except in the cases where by these By-Laws it is provided that votes shall be taken by ballot.

72. The decision of the majority of Fellows voting at any Meeting shall be considered as the decision of the Meeting.

73. The President, Vice-President, or other Chairman may, with the consent of the Meeting, adjourn any Meeting from time to time and from place to place, but no business shall be transacted at any adjourned Meeting other than the business left unfinished at the Meeting from which the adjournment took place.

74. At any Meeting a declaration by the Chairman that a resolution has been passed or lost, and an entry to that effect in the Minute-Book of the Society, shall be sufficient evidence of the fact, and in the case of a resolution requiring any particular majority, that it was passed by the majority required, without proof of the number or proportion of the votes recorded in favour of or against such resolution.

75. Minutes shall be made in a book provided for that purpose of all resolutions and proceedings of General Meetings, and any such minutes, if purporting to be signed by the Chairman of the Meeting at which such resolutions were passed or proceedings had, or by the Chairman of the next succeeding Meeting, shall be received as evidence of the facts therein stated.

76. Visitors may be present at any Meeting if introduced by Fellows, and provided they sign their names in the Attendance Book.

#### *A. Ordinary.*

77. The Ordinary Meetings of the Society shall be held at 8 o'clock P.M. on the third Wednesday in each month, from October to December, and February to June inclusive, or at such time and on such other date as the Council may appoint.

78. The ordinary course of business, unless otherwise determined by the Council, shall be as follows :—

1st. The minutes of the proceedings of the previous Meeting shall be read, submitted for approval, and if approved, signed by the President, Vice-President, or other Chairman of the Meeting.

2nd. The certificates of candidates for election shall be read and the ballot for the election of Fellows shall take place, and New Fellows admitted to the Society by the President, Vice-President, or other Chairman of the Meeting.

3rd. The donations received since the last Meeting shall be announced.

4th. The objects exhibited shall be described.

5th. Scientific communications shall be read and discussed.

6th. Any other business connected with the affairs of the Society shall be transacted which can be properly transacted at an Ordinary Meeting.

79. No question relating to the By-Laws or the management or affairs of the Society shall be discussed or voted upon at any Ordinary Meeting.

#### *B. Annual.*

80. The Annual Meeting shall be held at 8 o'clock P.M. on the third Wednesday in January, or at such time and on such other date as the Council may appoint.

81. At this meeting the Council shall submit its Report of the Society's proceedings and the Audited Accounts of the Treasurer. The ballot shall take place for the election of the Council for the ensuing year, and any alteration proposed in the By-Laws of the Society shall be discussed and, if necessary, voted on. The President shall read his Annual Address. Any other business connected with the affairs of the Society shall be transacted which can be properly transacted at an Annual Meeting.

82. The President, Vice-President, or other Chairman shall appoint two Scrutineers from among the Ordinary Fellows present, not being members of the Council or nominated for election thereto, to take the ballot for the election of the Council.

83. The Scrutineers shall receive the balloting papers from the Fellows present and entitled to vote, and shall report the names of the Fellows elected and the number of votes to the President, Vice-President, or other Chairman, who shall thereupon announce the names of the persons elected.

84. Any balloting paper containing a greater number of names for any office than the number to be elected thereto shall be rejected by the Scrutineers.

### *C. Special.*

85. The Council may at any time convene a Special General Meeting.

86. Any ten Ordinary Fellows may, by a requisition in writing signed by them specifying the object of the Meeting, require a Special General Meeting to be held for the purpose of discussing and voting upon any question relating to the By-Laws or the management or affairs of the Society; and the Secretaries, upon receiving such a requisition, shall call a Meeting accordingly.

87. One week's notice at least of every Special General Meeting shall be given, either by announcing the same at the Ordinary Meeting immediately preceding the Special Meeting, or by notice in writing served upon the Ordinary Fellows resident in the United Kingdom, as hereinafter provided. Such notice shall state the place, day, and hour of meeting, and the general nature of the business for which the Meeting is called, and no other business shall be brought forward thereat.

## **VIII. Sectional Meetings.**

88. Sectional Meetings may be held by the Fellows at such times and under such regulations as may be determined from time to time by the Council.

## **IX. Library and Cabinet.**

89. The books, instruments, and other property of the Society may be inspected and used by the Fellows, under such regulations as the Council may from time to time determine.

90. No instruments or other property shall be taken out of the Society's Rooms except under such regulations as may be determined from time to time by the Council.

91. The Assistant Secretary shall make and keep up a Catalogue of all the property of the Society, other than that included in the Catalogues of the Librarian and Curators respectively; and shall

make an annual report to the Council as to the condition thereof. He shall also keep a list of all donations to the Society, and of all property borrowed by the Fellows.

### **X. Papers and Publications.**

92. All papers shall be approved by the Council previously to being read at any Meeting, but such approval shall not be taken as expressing any opinion upon any of the statements contained in such papers.

93. Papers shall be read in such order as the Council shall think fit.

94. The Society shall in all cases have the right to publish any paper read, or taken as read, at any Meeting.

95. Papers shall be published either in the Journal of the Society, or in such other manner as the Council shall think fit.

96. The copyright of a paper (and of the drawings, if any, accompanying it) read, or taken as read, at any Meeting, shall be the property of the Society, unless the author at the time of sending the same shall stipulate to the contrary, and provided that the Society publish the same within six months after its receipt.

97. The authors of papers published by the Society shall be entitled to such number of copies thereof as the Council shall from time to time determine.

98. The Council may present copies of any of the publications of the Society to, or exchange the same with, such persons and Societies as they may think fit.

### **XI. Notices.**

99. A Notice may be served upon any Fellow either personally or by sending it through the post in a prepaid letter addressed to such Fellow at his last known address.

100. Any notice sent by post shall be deemed to have been served on the day following that on which it was posted; and in proving such service it shall be sufficient to prove that the notice was properly addressed and posted.

101. Any Fellow residing at any place not within the Postal Union may name an address within the Postal Union at which all notices shall be served upon him, and all notices served at such address shall be deemed to be well served. If he shall not have named such an address, he shall not be entitled to any notices or to receive any of the publications of the Society.

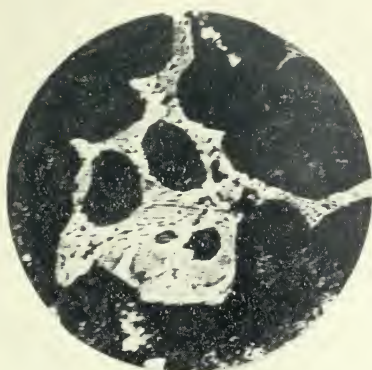
### **XII. Alteration of By-Laws.**

102. No alteration in the By-Laws of the Society shall be discussed or made, except at an Annual Meeting, or at a Special General Meeting convened for the purpose.

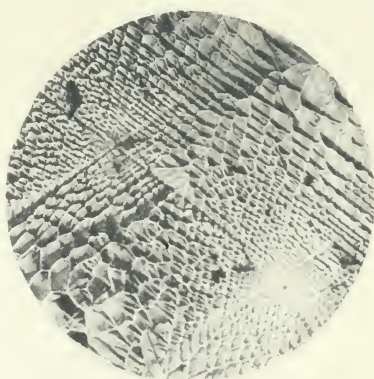
103. Notice of every alteration proposed to be made in the By-Laws shall be given either by announcing the same at the Ordinary or Annual Meeting immediately preceding the Meeting at which the alteration is intended to be proposed, or by notice in writing served upon the Ordinary Fellows resident in the United Kingdom as hereinbefore provided.

### **XIII. Interpretation.**

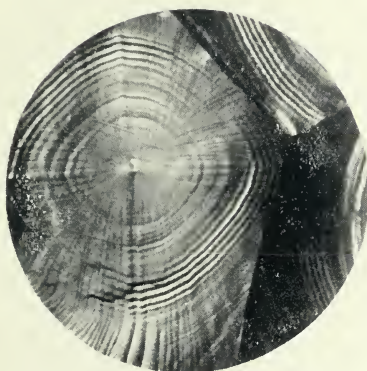
104. In the construction of these By-Laws words denoting the singular number only shall include the plural number also, and *vice versâ*, and words denoting the masculine gender only shall include the feminine gender also, unless there be something in the context inconsistent therewith.



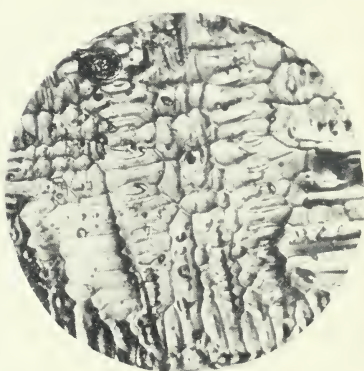
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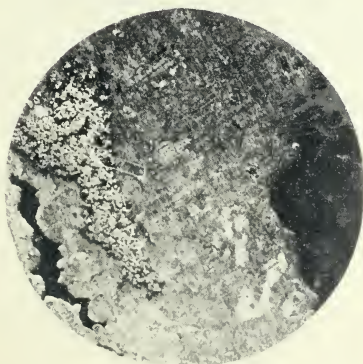
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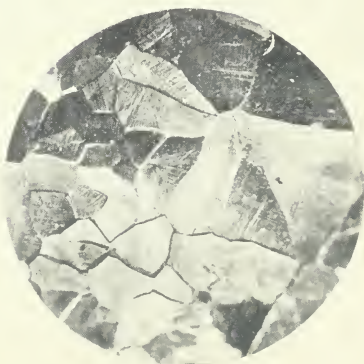
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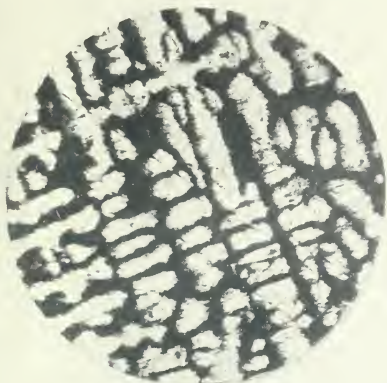


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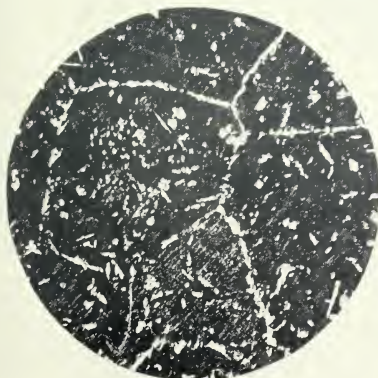
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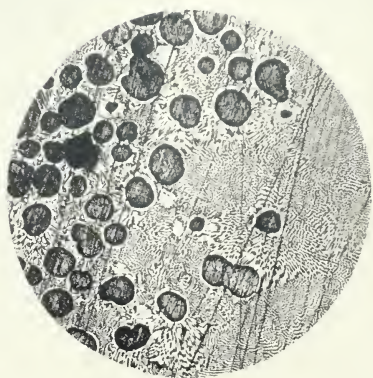
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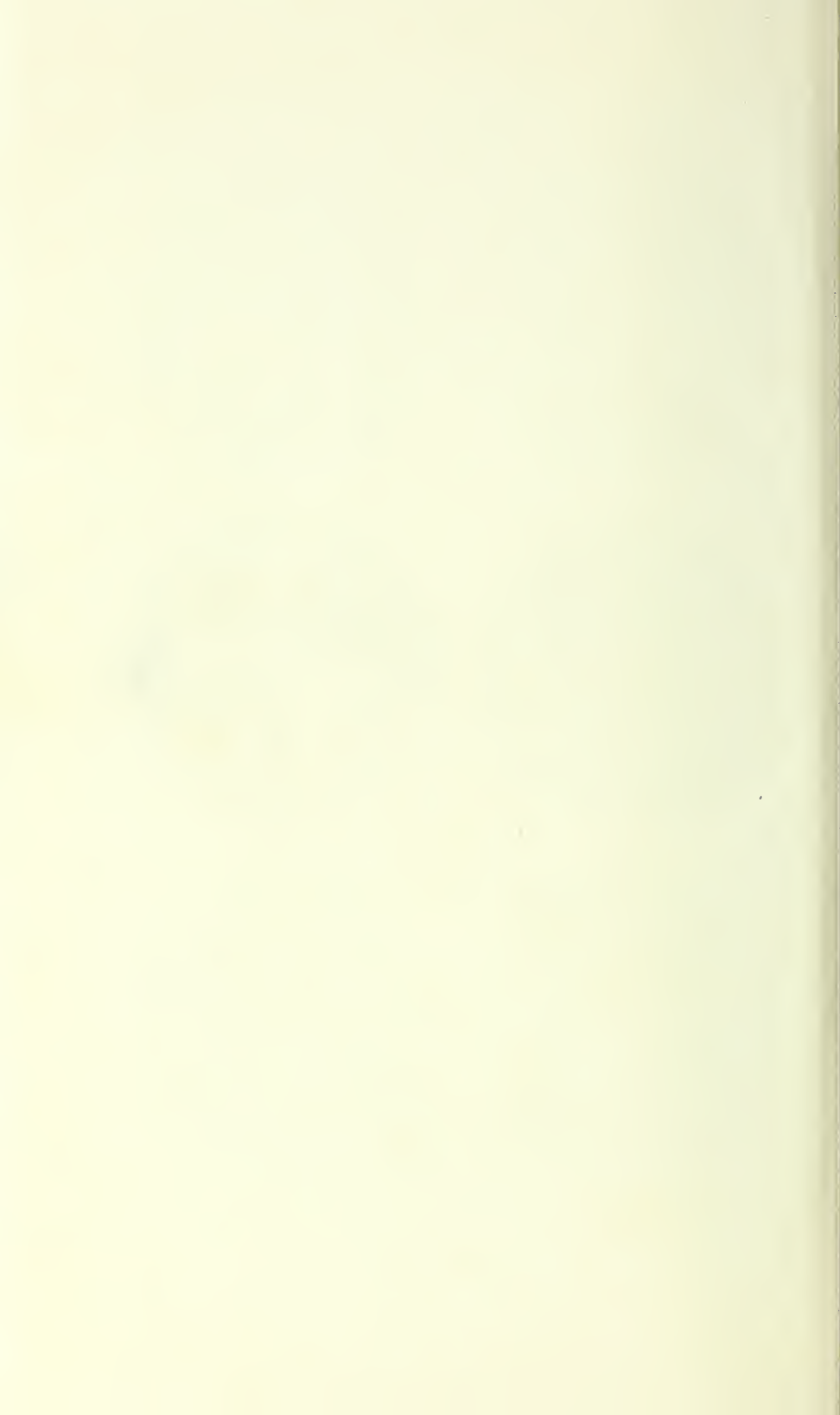
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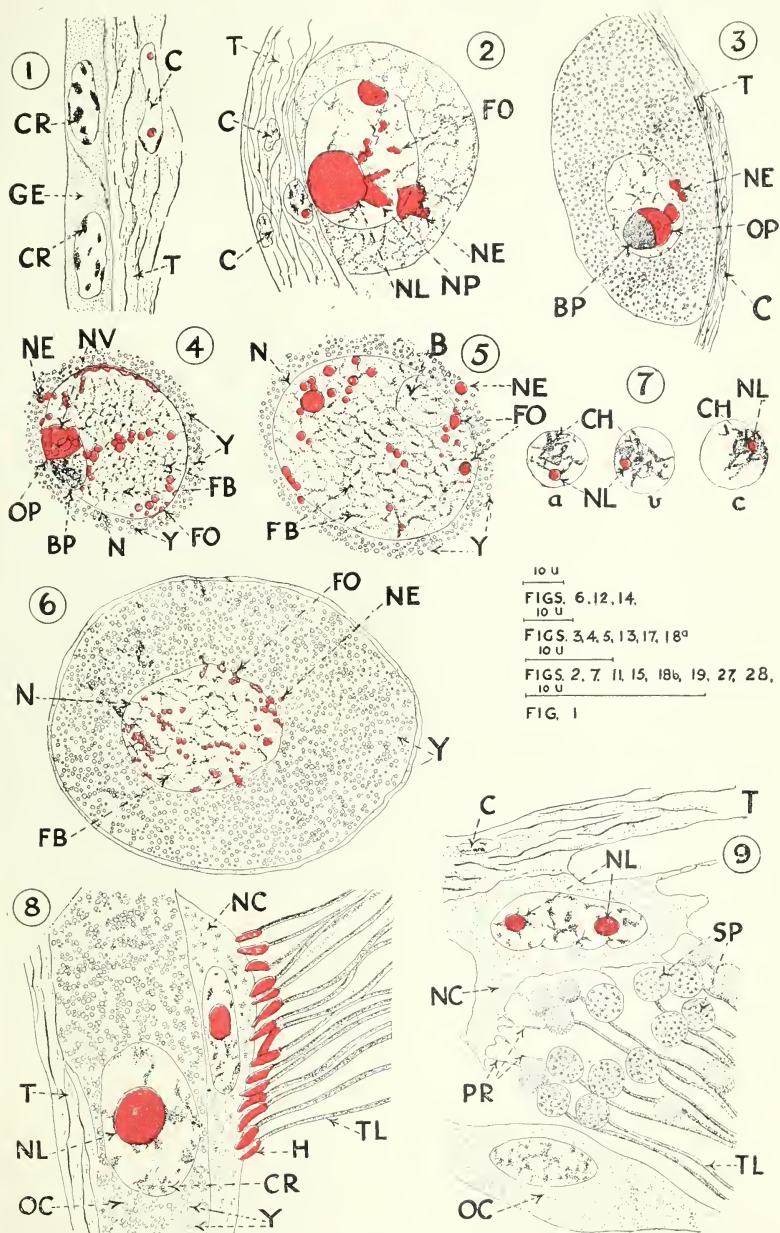


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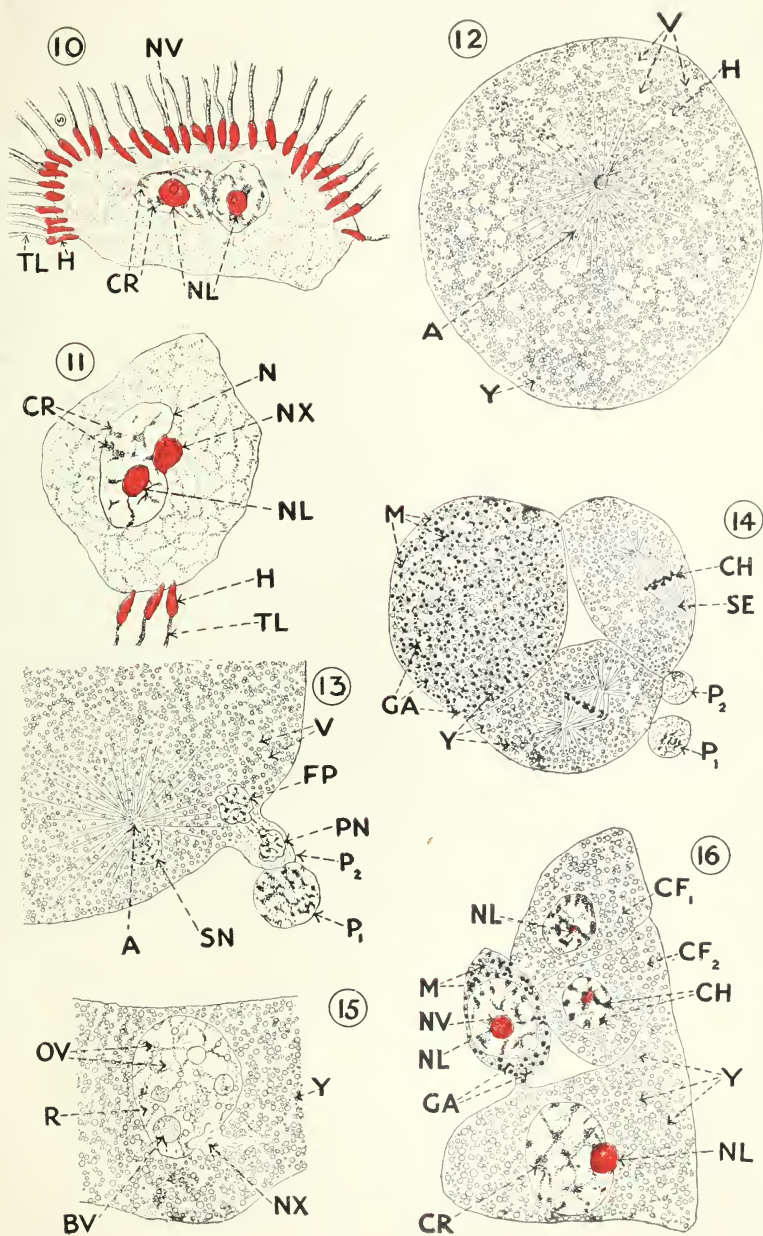


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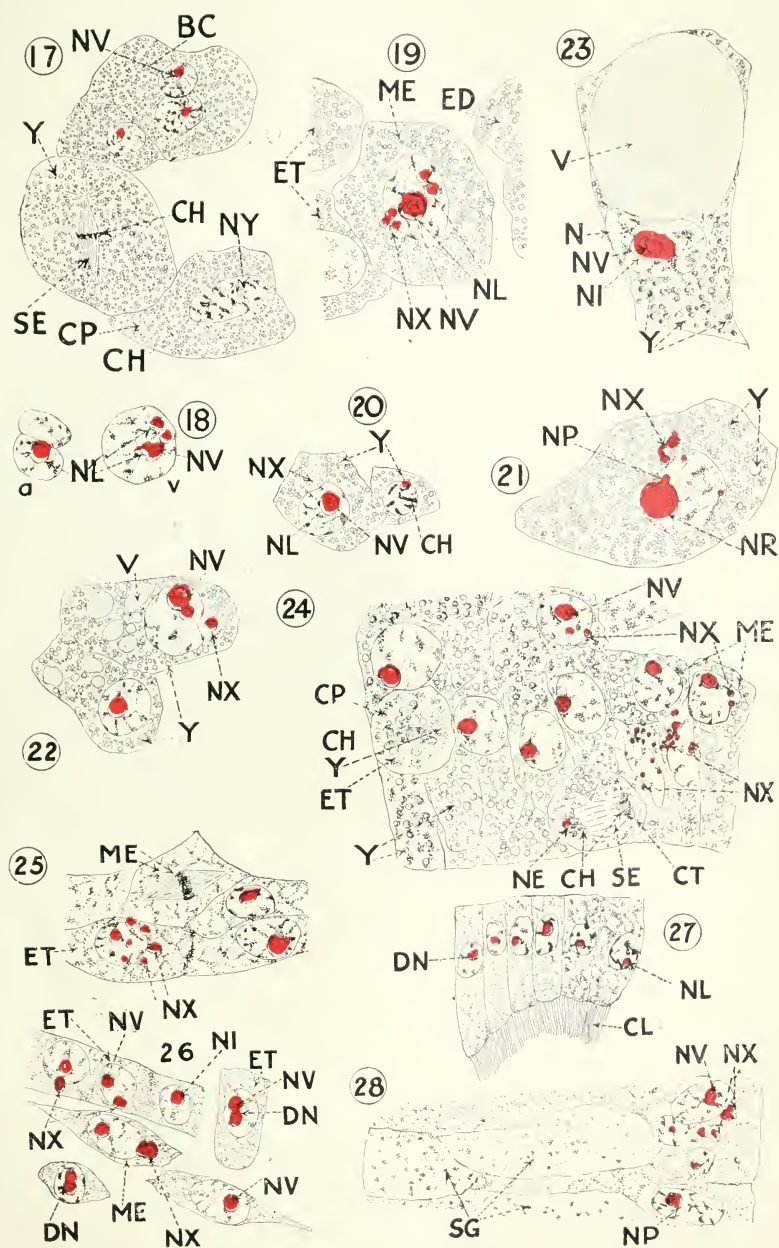








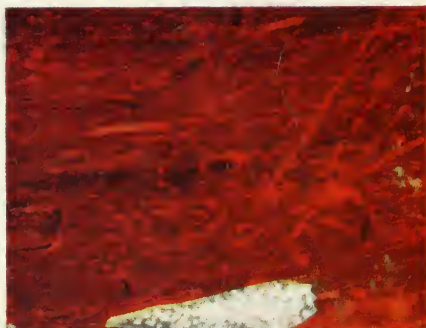




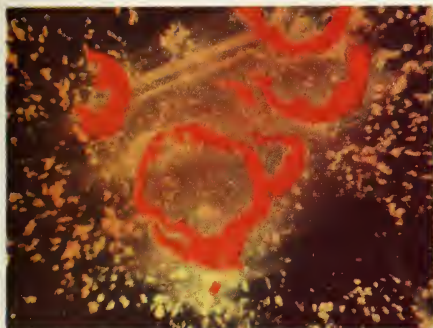




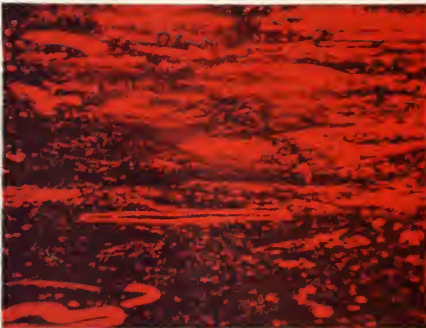
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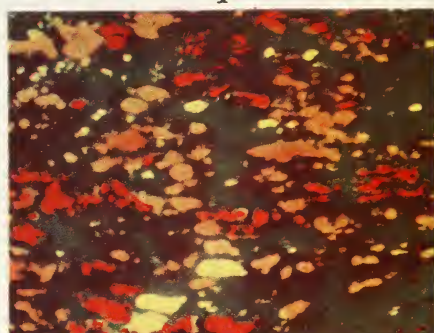
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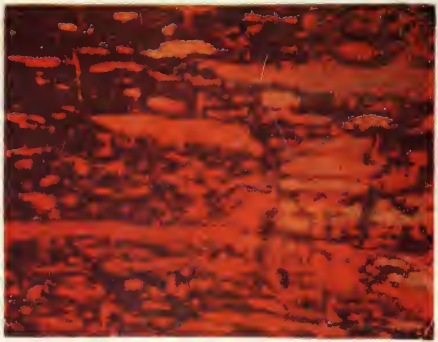


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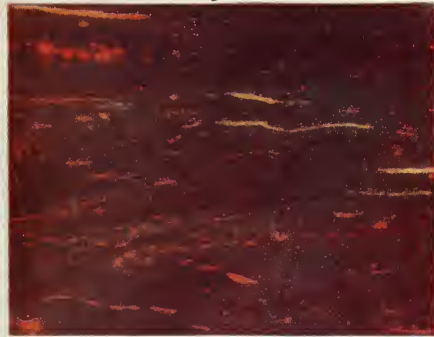




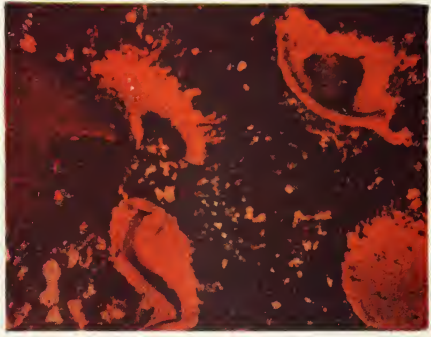
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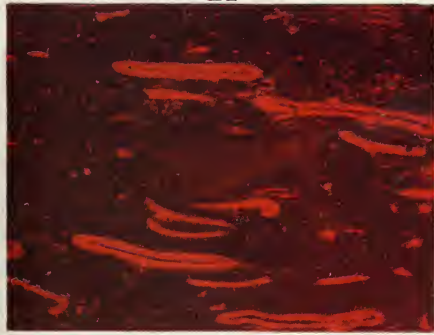
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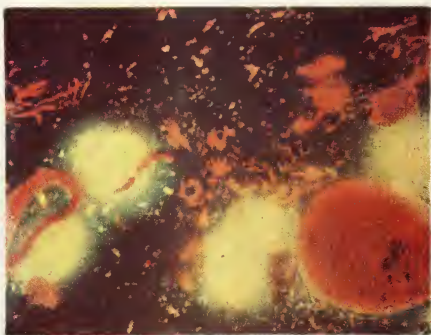
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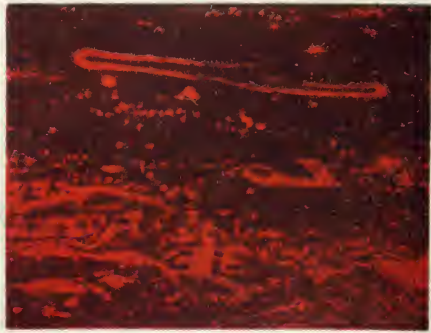
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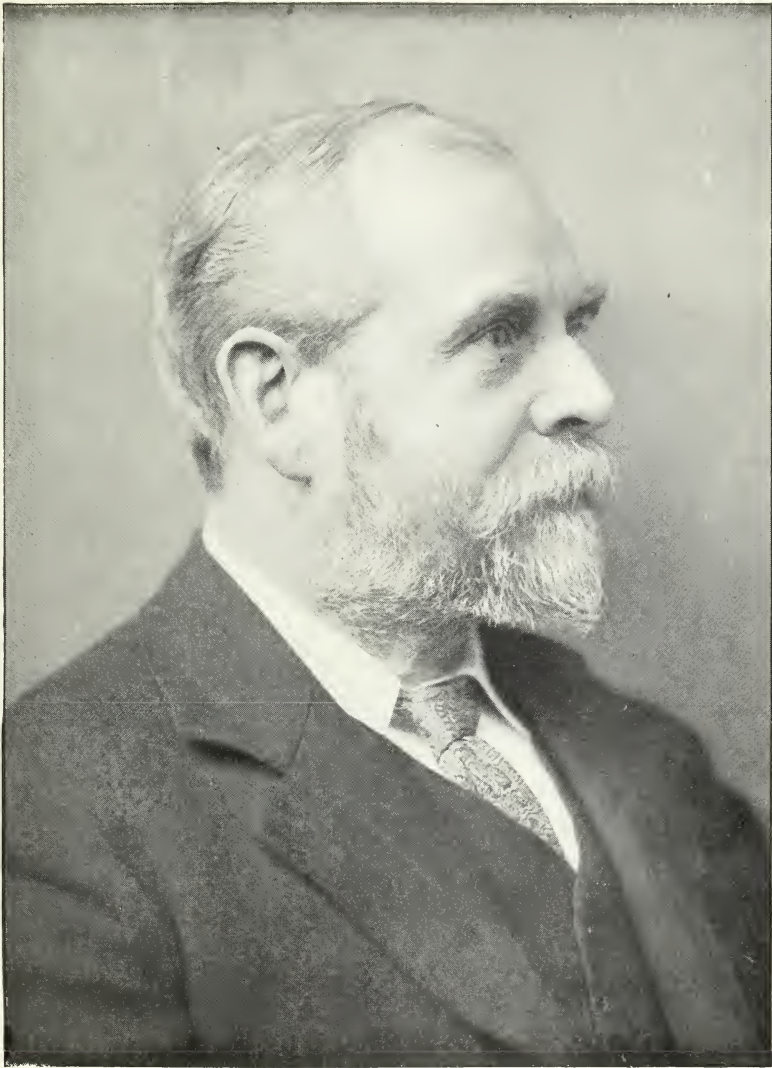


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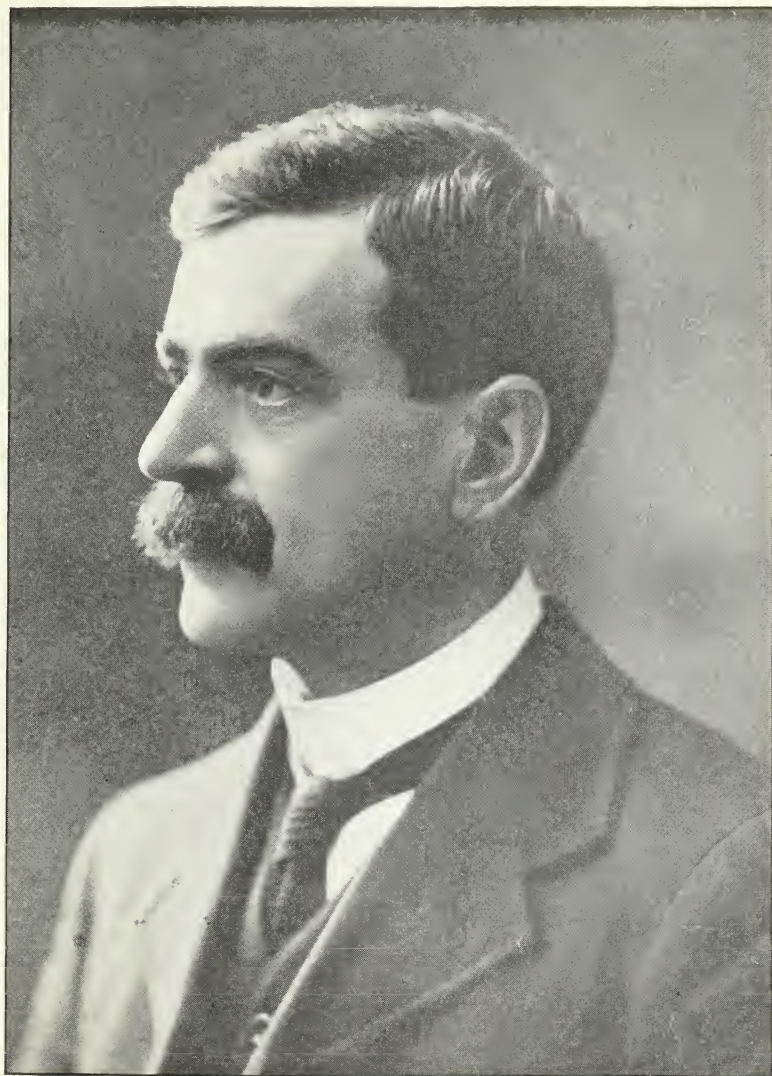
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SIR GERMAN SIMS WOODHEAD, K.B.E., M.D., LL.D., F.R.S.(Edin.)





BENJAMIN MOORE, M.A., D.Sc., F.R.S.





FIG. 1.

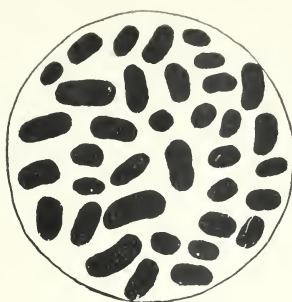


FIG. 2.

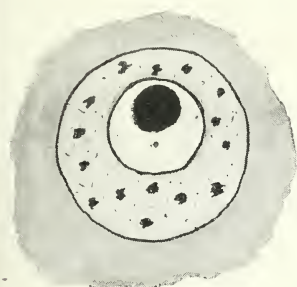


FIG. 3.

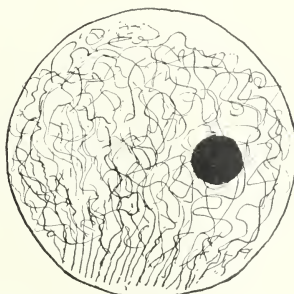


FIG. 4.



FIG. 5.

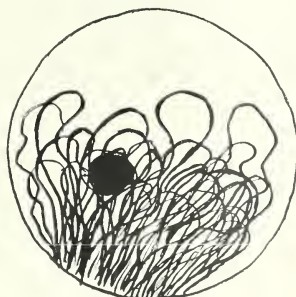


FIG. 6.



FIG. 7.



FIG. 8.

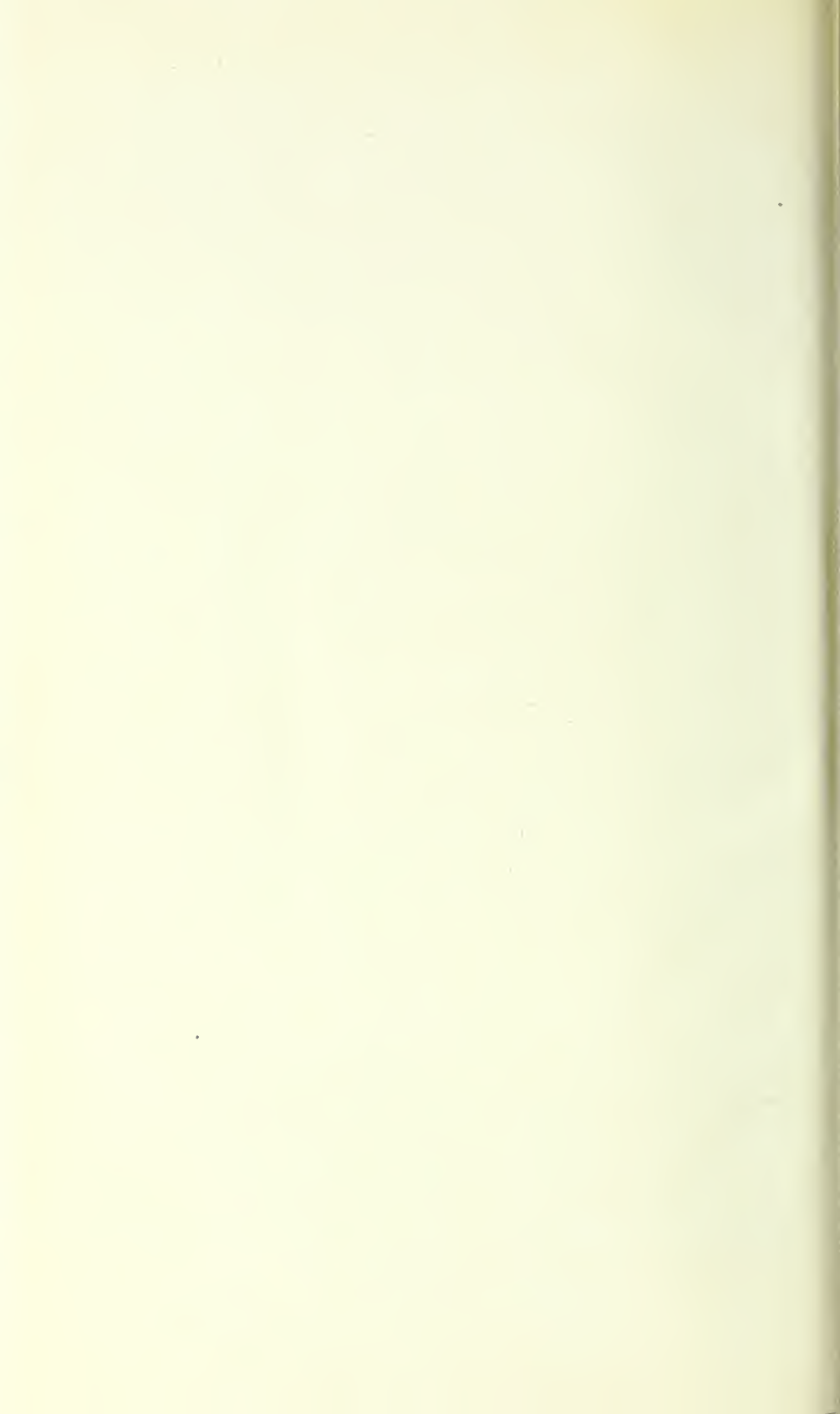




FIG. 8a.

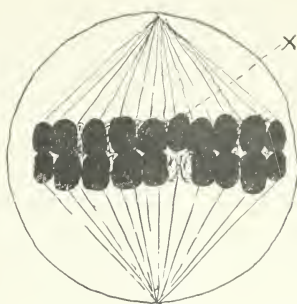


FIG. 9.



FIG. 10.

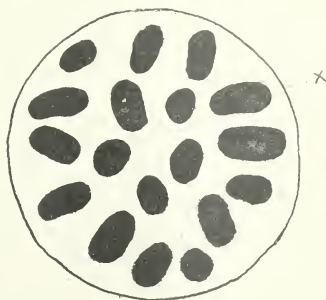


FIG. 11.

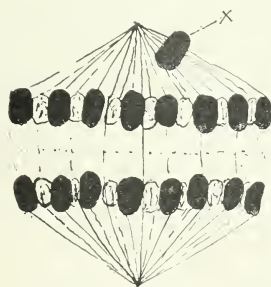


FIG. 12.

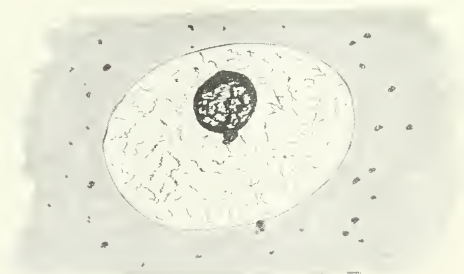


FIG. 14.

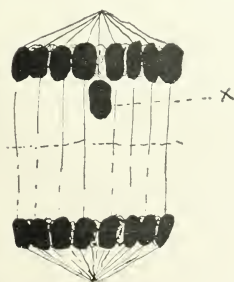


FIG. 13.

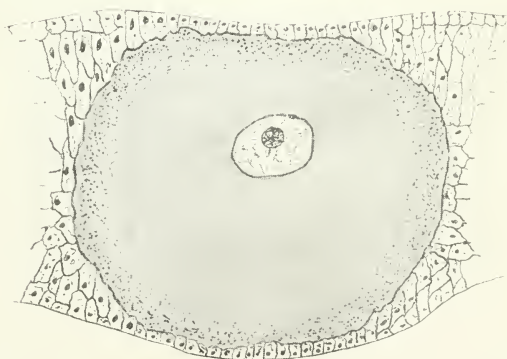
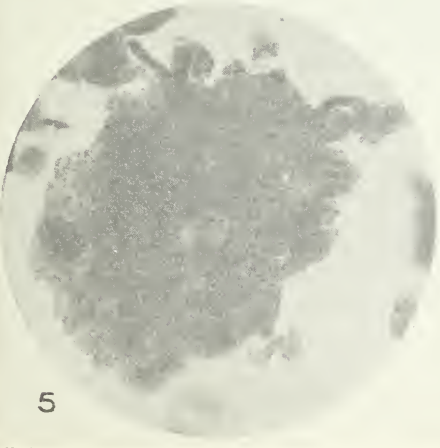
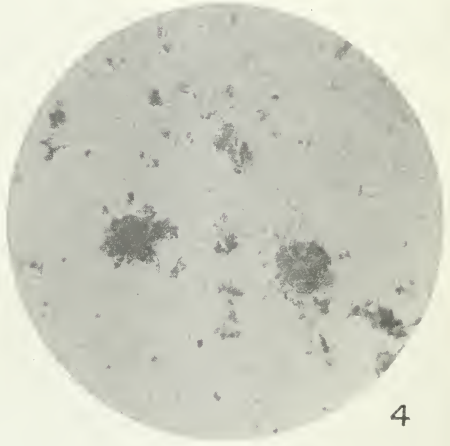
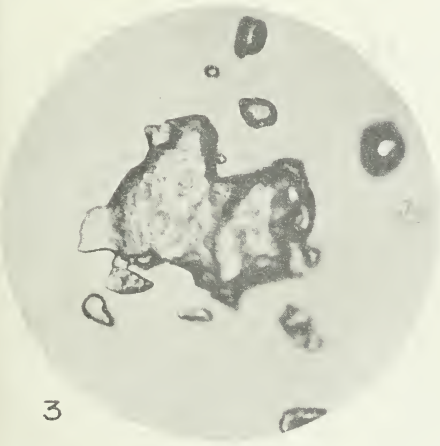
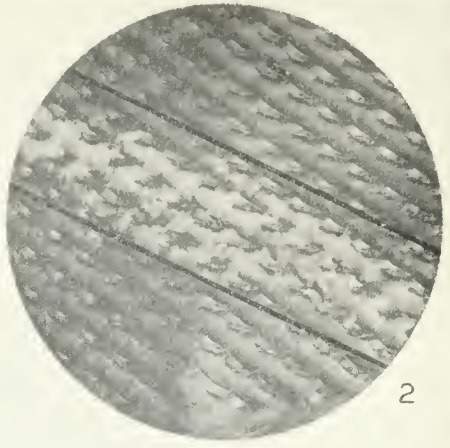
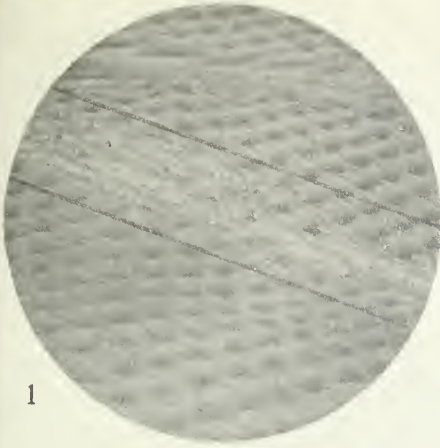
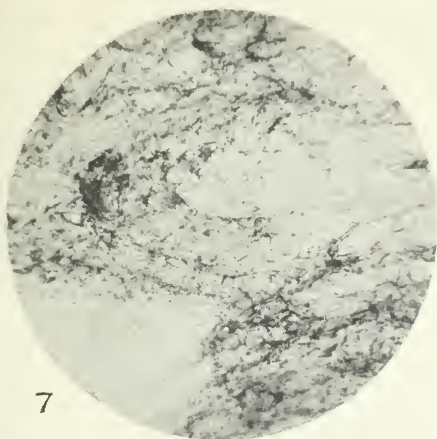


FIG. 15.

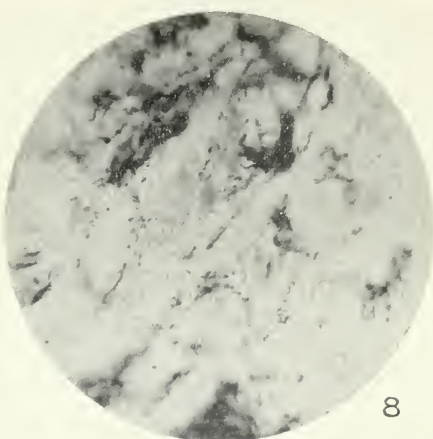




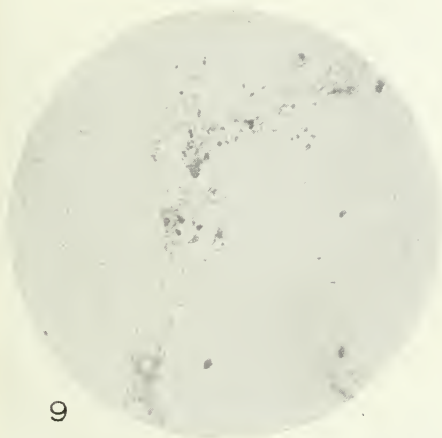




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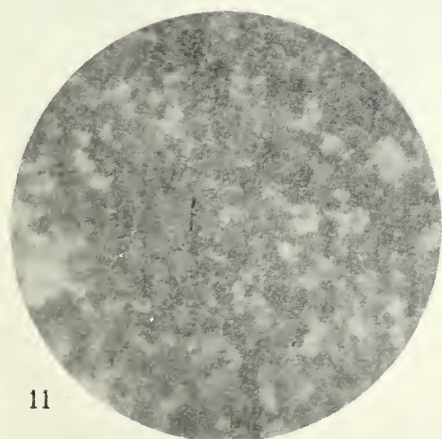
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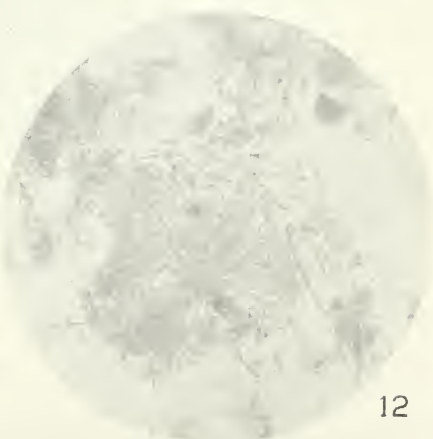
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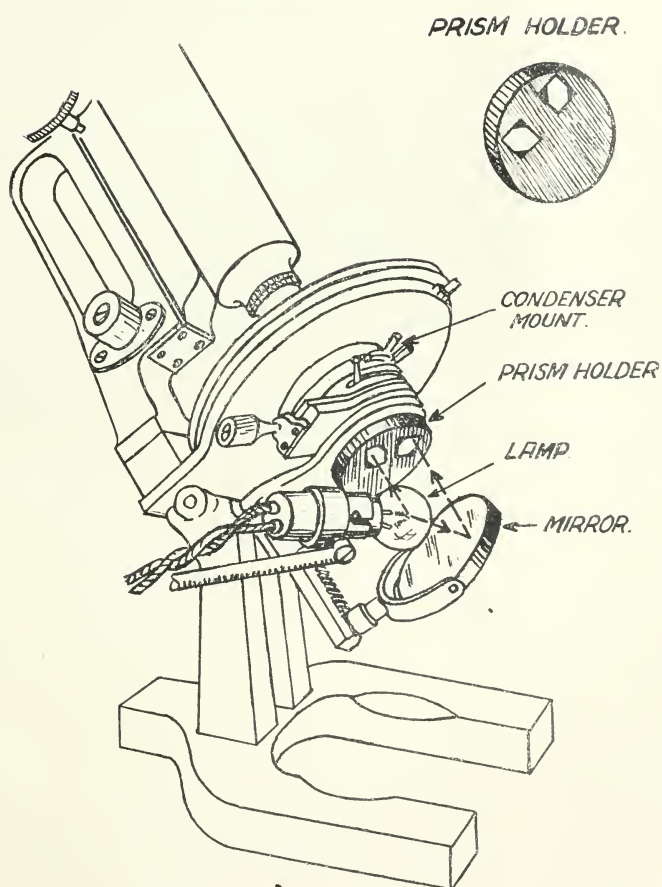
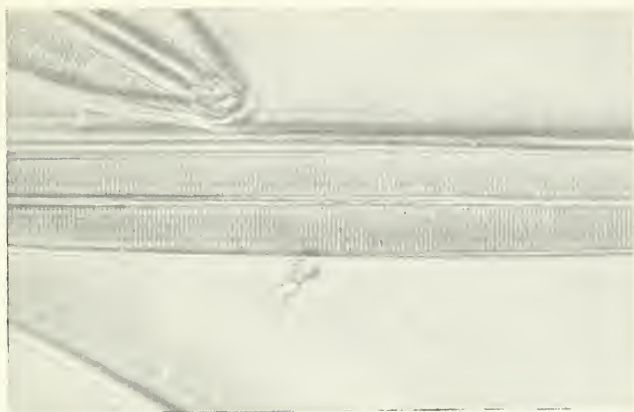


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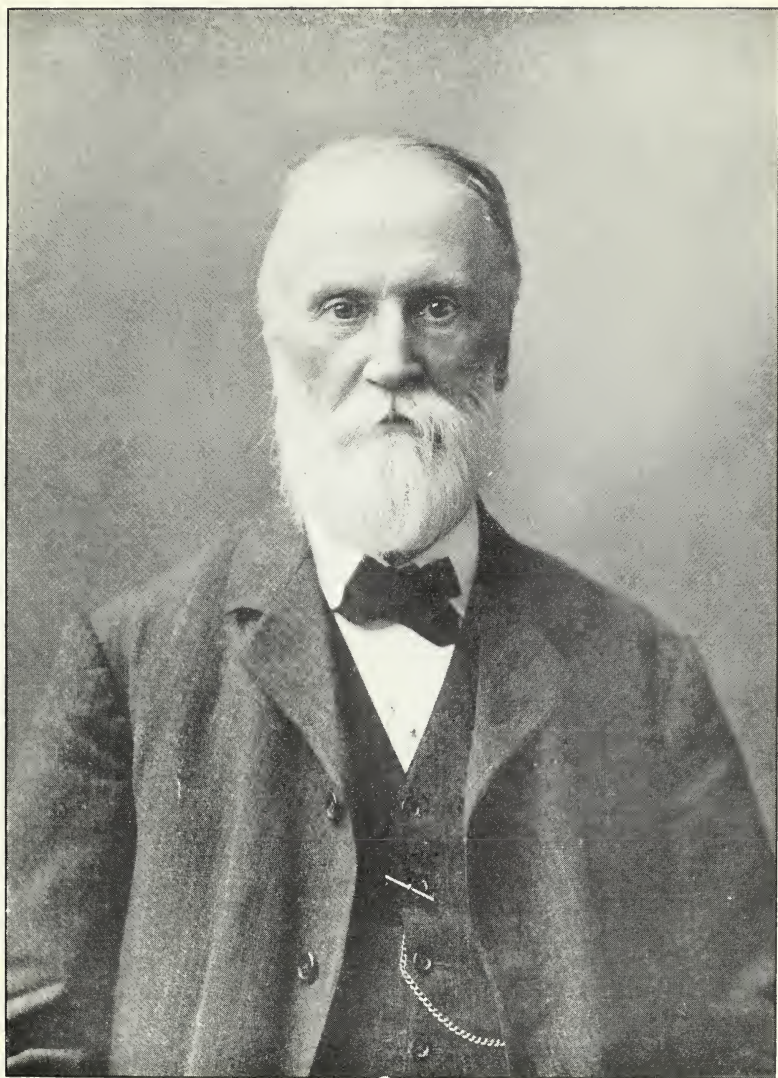
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Arrangement of Illuminating Apparatus to produce two beams of oblique light polarized at  $90^\circ$  to each other.





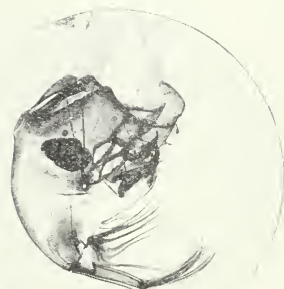
BAYFIELD—GIPSY HILL

WILLIAM CARRUTHERS, PH.D., F.R.S., F.L.S., F.G.S.





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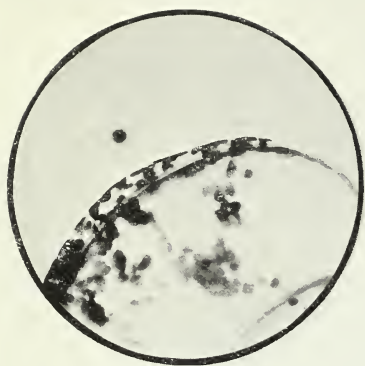


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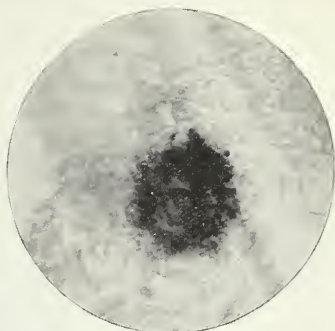


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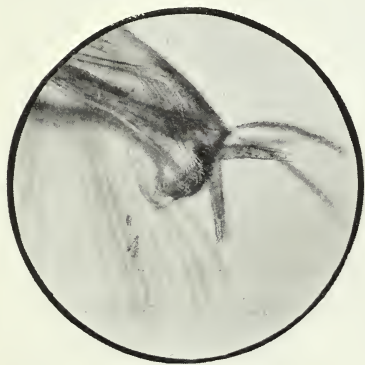




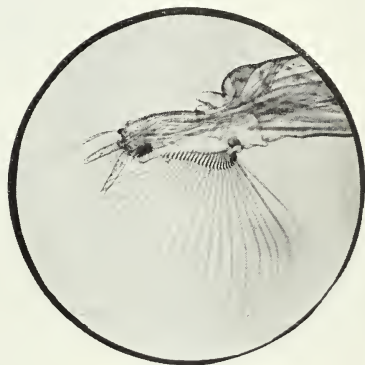
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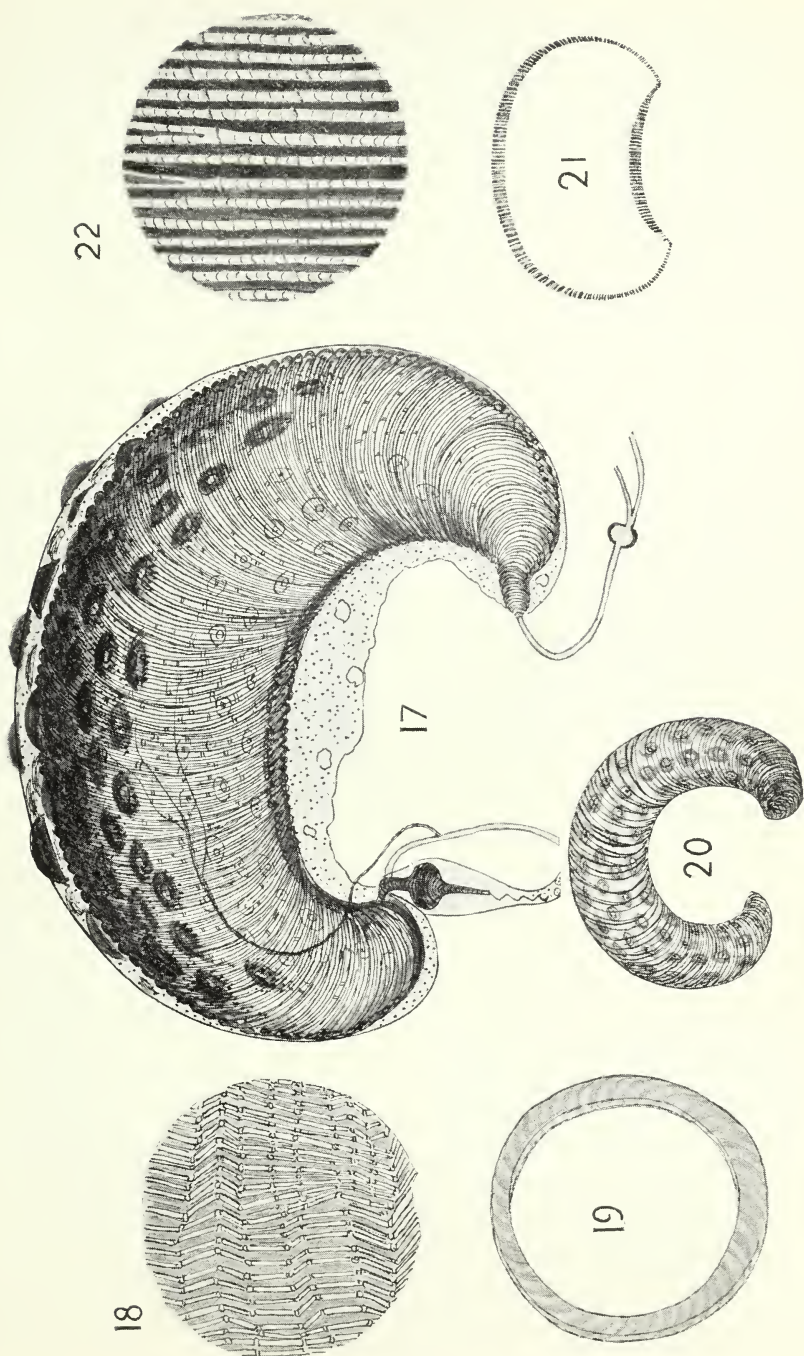


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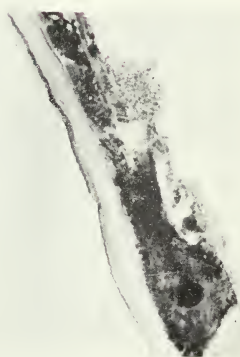
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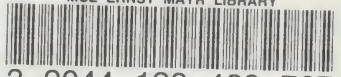
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